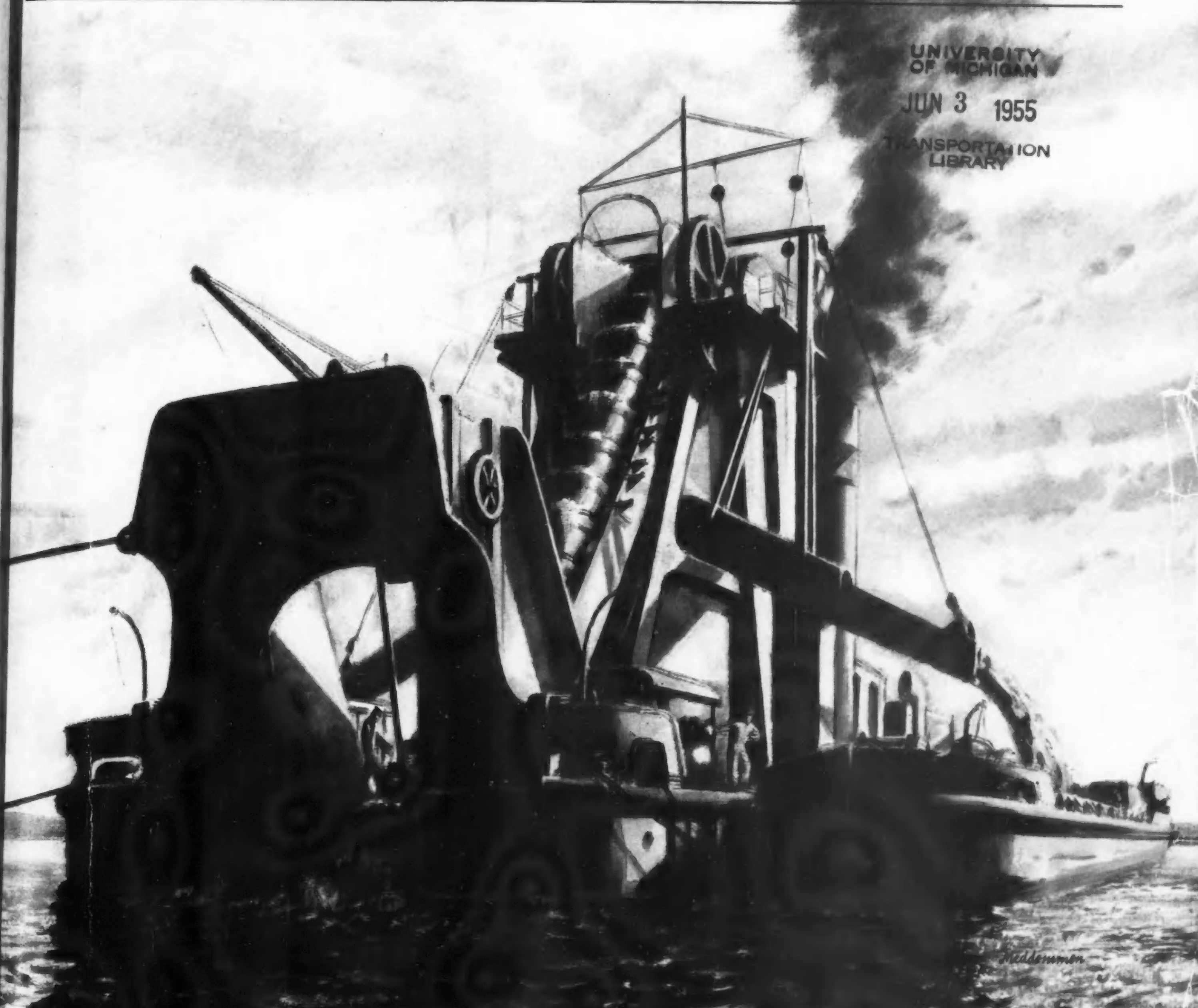
The
Dock & Harbour Authority

No. 415. Vol. XXXVI. | MAY, 1955. | Monthly 2s. 6d.



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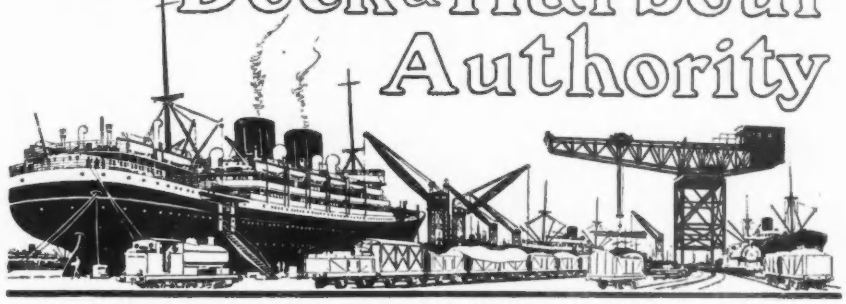

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The Dock & Harbour Authority

An International Journal with a circulation extending to 83 Maritime Countries

No. 415

Vol. XXXVI.

MAY, 1955

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Editorial Comments

The Port of Hamburg.

In the August, 1953, issue of this Journal, we published an account of the history and development of the town and port of Hamburg. This also gave brief details of the rehabilitation and reconstruction plans which were put into effect during the years following the Second World War.

We are now publishing in this, and in the following issue, a review of the further development works which have been carried out during the last few years. The technical details should prove of interest to many port engineers.

Board of Survey Report on Inland Waterways.

As stated briefly in our last issue, the Report of the British Transport Commission of the Board of Survey of Canals and Inland Waterways was issued early in April last.

The authors of the Report are to be congratulated for their conclusions and opinions expressed, which are as admirable for their conciseness and clarity, as they are for their soundness. The most important recommendation is contained in their separation of the canals into three categories. Firstly, there are those suitable for further development; the second group is to be retained meanwhile, whilst the third group should be handed over to other authorities so that the British Transport Commission is relieved of the burden of maintenance.

We welcome the proposal to transfer the canals in the third category to River Boards, and the Caledonian and Crinan canals to the Secretary of State for Scotland. If the present annual losses of £240,000 on these are cut by reductions in maintenance costs (by further economies in maintenance beyond those already achieved by the Commission), and if some contribution is obtained from private sources, the ensuing figure should not be too large to be accepted as a direct Government responsibility. An important benefit which would follow from this disposal operation would be that the Commission's staff would be able to concentrate on its proper task, and the Management would be better able to evaluate the level of operating efficiency of its commercial activities. As an immediate step, the suggestion is made that the responsibility for the unremunerative waterways should be detached from the duties of the General Manager and the Divisional Waterways Officers. This appears to be highly practical, and there seems no reason why it should not be done at once, if a suitable small staff can be found to relieve the management of this work. Sir Reginald Hill, writing in "Modern Transport," does not, however, readily accept this suggestion, since he fears that it may merely result in duplication of staff and effort. His views will no doubt carry much weight. If, of course, the transfer to River Boards could be rapid, the question of the temporary management of uneconomic canals would not arise; but this is unfortunately unlikely.

The other proposals in the Report, reviewed in detail on a later page, include the separation of management for docks from that of waterways, and the return to canal management of the docks at Gloucester, Sharpness, Weston Point and Limehouse.

The future policy for the British canals now awaits the decision of the Government. In the past, the advice tendered by Royal Commissions and other investigators on this subject has not been taken by the Government of the day. If, this time, enough courage is shown to press the proposals of the Board into effect, there is a chance that at last inland water transport will show some net profit on its operation.

Thames Pollution Problems.

That the River Thames is polluted, and has been so for many years, is well known. It is not however so well appreciated by the general public that the pollution is rapidly increasing in intensity, due to the increase of industry and population along its banks. It is no exaggeration to say that this great waterway which serves the greatest city in the world is on the way to becoming a gigantic sewer; but it is also fair to say that the problems facing the numerous authorities whose activities impinge on this river are problems which can and will confront the inhabitants of any large and expanding seaport situated on an estuary.

The seriousness of these problems may be judged from the fact that although numerous investigations into the causes of and remedies for pollution are actively being carried out, the Port of London Authority has recently felt it necessary to call a conference to consider what remedial measures can be set on foot immediately without waiting for the completion and collation of the detailed investigations.

Lord Waverley, Chairman of the Port of London Authority, reviewed the present position in his opening address to the conference, which is printed in full in the "P.L.A. Monthly" for April, 1955. One of the most striking changes in the river during the past twenty years has been the decline in the amount of dissolved oxygen in the water. Briefly this decline seems to be due to the increased pollution load which is using up most of the available oxygen and could with advantage use much more. The decline is aggravated by the presence of detergents, whose presence in the sewage even in small concentration has the effect of reducing the surface intake of oxygen from the atmosphere. Further oxygen starvation is caused by the large use of cooling water, 4,000 million gallons a day. This water becomes de-oxygenated in use, and returns to the river lacking oxygen, and with an increased temperature, which in itself reduces its oxygen capacity, and that of the water with which it mixes.

The total average intake of oxygen from various sources is estimated to be approximately 1,500 tons per day. That it is grossly insufficient is shown by the existence of a variable but considerable "anaerobic zone" in which dissolved oxygen is virtually absent. Estimates of the length of this zone for the current year range from 15 miles when the flow of fresh water over Teddington Weir is high (1,000 million gallons per day), to 25 miles when the flow at Teddington falls to 200 million gallons per day.

Editorial Comments—continued

While there are many associated problems, both chemical and physical, which have to be considered both separately and in relation to each other, it is perhaps not an oversimplification to repeat what Lord Waverley said, and emphasised, namely that the lack of oxygen is probably the most important single factor in the pollution of the river. That being so, it is, in the opinion of this Journal, not impracticable to meet this major part of the total problem by artificially aerating the river at selected locations.

Such a suggestion sounds on the face of it to be too large a task to be practicable. However, it may be said that if compressed air were injected into the river at sites which were most favourable to the complete dissolving of oxygen, i.e. in the anaerobic zone, and if the rate of injection were 10,000 cubic feet per minute, there would be an increase in the oxygen intake of the river as a whole of nearly 8 per cent. But what is perhaps more to the point is that if the aeration took place as suggested in the anaerobic zone, the oxygen would be added to the river water where it is most needed to assist in oxidising the polluting matter. There seems little doubt that the benefits to be derived would be out of all proportion to the operating cost (which is in the region of £35,000 per annum).

Oxidation is the same thing as combustion, accompanied by flames only if the process is rapid. Although the kind of combustion which we now advocate as a necessary antidote to Thames pollution is not of the inflammatory variety, yet it may be said that what we propose is as near to the proverbial "setting the Thames on fire" as it is possible or desirable to get.

It would appear unlikely that other remedial measures will in themselves succeed in putting the clock back, but rather will contain the river pollution at something like its present level. Certainly it seems that the oxygen content of the river is unlikely to be restored to a reasonable level by nature unaided. Hence we believe that this particular problem should be squarely faced and dealt with by artificial means.

Water Pollution Research.

The annual report of the Water Pollution Research Board was also published during the past month; abstracts appear on another page of this issue. As is to be expected, a large proportion of the research output is concentrated on the River Thames and its pollution, but it is necessary to study the full report to appreciate the complexity of the various phenomena which contribute to the total picture.

Other subjects dealt with include investigations of a biological method of removing cyanide and other industrial waste prior to releasing the fluids into the sewer.

Maximum Draft in Suez Canal.

In a recent issue we described and commented on the accident which occurred in the Suez Canal on the last day of 1954 when the tanker "World Peace" collided with the swing bridge at El Ferdan.

It is evident from current trends in regulations covering the use of the Canal that the transit of the largest tankers is accomplished with only a small margin of safety, even when allowance is made for the promised demolition of the bridge in question, and it is interesting to note that the latest regulations issued by the Suez Canal Company refer not only to conditions of draught in north-bound tankers but also their qualities of steering and speed while on a north-bound passage. These regulations are as follows:—

"Maximum draft of north-bound vessels through the Suez Canal may be permitted up to 35-ft. at any point of the hull (forward, amidships or aft), as a result of the improvement works. To make passage on a 35-ft. draft, vessels must comply with the following conditions:—

"They must be provided with draft marks forward, amidships and aft, to port and starboard, and be able to reduce their draft by 1-ft. as required by the canal regulations, while complying with the requirements of the International Load Line Convention.

"The vessels should also have shown that their steering and speed are satisfactory on a draft of 34-ft., and have been authorised to pass through on 34-ft. 6-in., and have shown on a north-bound passage that their steering qualities and speed are acceptable on that draft.

"In addition, the vessels must have been authorised to make an experimental passage on 35-ft., and have shown, on a north-bound passage, acceptable steering qualities and speed on that draft, and have been given permission after this experimental transit to make subsequent north-bound passages on the draft.

"The company wishes to make it clear that permission to pass through on a 35-ft. draft may be cancelled at any time, either, in the case of any particular vessel, because of loss of steering qualities or speed, or, in the case of all vessels, if the company were to find that such transits adversely affected works in progress or the common interests of users of the canal.

"The trial passages of a vessel will not cover her sister-ships."

The last paragraph shows that the Canal Company are taking no chances and that each tanker must exhibit the required performance.

An account will shortly appear in this Journal of proposed improvements which the Canal Company are about to undertake in order to increase safety and speed of transit, notwithstanding the fact that the Canal reverts to Egyptian ownership in fourteen years.

New Development in Steel Sheet Piling.

The versatility of steel sheet piling is well known in many different branches of civil engineering, and manufacturers in this field have shown praiseworthy enterprise and initiative. Thus, when the occasion has arisen, they have not hesitated to design and roll special sections for overcoming difficult problems, and in very many cases their ingenuity has resulted in strength with economy, a cardinal principle of sound engineering construction. In this issue we are publishing an article describing an ingenious adaptation of steel sheet piling for a varied range of dock construction works.

French engineers have been responsible for this development, the economic success of which appears to hinge on a specially rolled hollow triangular section in the shape of an equilateral triangle. This is used as the joint between straight transverse bulkheads and curved cofferdam walls, both of steel sheet piling construction, and in which the strength to withstand water or earth pressure is provided by the dead weight of the filling combined with the tensile strength of the piling itself.

By employing this method, it has been possible to construct several dock and wharf walls, gabions, dolphins and similar structures which appear to offer both economic and structural advantages. Where a large quantity of excavated or dredged spoil is produced, as so often happens in dock and harbour engineering, this adaptation of steel sheet piling enables such spoil to be used for permanent or temporary cofferdams with considerable economic advantage. If the available spoil has a steep angle of repose, then this advantage will be accentuated because a comparatively light section will be required.

Finally, it is necessary to point out that this new development does not claim to displace existing steel sheet piling, but rather emphasises the extraordinary adaptability of this form of construction. In practically every job where sheet piling is used, the design will be decided by local and geological conditions.

Completion of Mutwal Quay, Port of Colombo.

Early last March, the Mutwal Quay was officially taken over by the Colombo Port Commission. This is the first quay to be completed under the Port Development Scheme, a full description of which appeared in the December, 1951, issue of this Journal.

The Mutwal Quay was scheduled to be completed by the end of 1952, but various technical setbacks necessitated the French contractors asking for an extension of time.

For some months past the quay has been used to berth ships, and it appears that its premature use, and particularly the unloading of cargoes, has interfered with the final completion of the work.

The latest information available indicates that the Ceylon Government does not propose to proceed with the extension of the south-west breakwater, which was to comprise the third stage of the development scheme. It was intended to extend this breakwater to provide two additional berths for large ships, at an estimated cost of Rs. 10 million. The decision not to pursue the extension scheme is due not to financial reasons but to the fact that the breakwater would be exposed to the full force of the south-west monsoon.

The Port of Hamburg

A Review of New Construction

by R. R. MINIKIN

THE important seaport of Hamburg geographically and historically occupies a unique position in Western Europe. In the 13th century the town of Bruges was the main commercial port bordering the North Sea, and its merchants and shipowners were a power in themselves. From some motive not entirely clear today, the merchant adventurers of Bruges moved their centre of operations in the 14th century to Antwerp. Naturally, the prosperity of Bruges declined and Antwerp not only grew in importance, but in 1560 its population was no less than 100,000. It was in this century that its peak was reached as the foremost port of Western Europe, due mainly to the extensive trade in wool imports from England.

Then the emergence of Holland as a new state controlling the mouth of the Scheldt, or in other words, the outlet and inlet to the sea from Antwerp, brought the commercial interests of the latter to the verge of ruin. This condition lasted until 1795, when Napoleon internationalized the waterway. By this time the population of Antwerp had been reduced by 50 per cent.

The decline of Antwerp influenced the rapid growth of Amsterdam and Hamburg. At the time of Antwerp's difficulties the population of Hamburg was less than ten thousand, nevertheless it was the beginning of its importance, for most of the north European trade with England was diverted to its markets. By the sound direction of the commercial credits given by the Hamburg banks, it rapidly established its place as the leading Hanseatic port and the greatest city in Germany. About the same time the first Chamber of Commerce was founded, and with it there was opened up a wide field of trade in western Europe. The only setbacks to this long-standing commercial connection have been the result of wars, the Napoleonic and the two World wars.

The port of Hamburg has grown up on the flat alluvial land south of the North Elbe, whilst the city has developed as the residential zone on the north bank, centred about the higher "geest" land between the Elbe and the small Alster tributary near the shallowest crossing of the old time Elbe. The Alster was dammed to form a lake, from which water power was at one time obtained. The density of the population in the city is among the highest in Europe, and the concentration of industrial zones separated from the residential areas gives rise to a difficult transport problem.

The Direction.

However, besides being a great commercial centre it has the interesting feature of being a fine city of beautiful buildings and orderliness. What buildings of the half timbered type remain from the devastation of war are models and reflections of the old merchant adventurers' prosperity, and whilst the greater part of the 1,500,000 inhabitants live in tenements, the foresight and planning capacity of the city fathers and past Burgomasters have preserved many æsthetic amenities. It has the distinction of being itself a State in which powerful control is exercised by the Burgomaster, not only over matters affecting the social services, but on all matters of importance relating to commercial and maritime interests. He, in effect, is the active prime minister or Governor of State affairs, and operates through his departmental chiefs or ministers. The port of Hamburg is entirely controlled by the Minister of Traffic, who appoints the administration and the technical direction.

The large organisation dealing with the maintenance and development of the port under the Baudirector, Dr. Muhlradt, is known as the "Strom und Hafenbau" (River and Harbour Construction) division. This is sub-divided into several departments: (a) warehouses, sheds, moorings, dolphins, quay walls, jetties, bridges, landing stages, etc. (b) River training, river banks repair, dredging, ship locks, etc. (c) Mechanical and electrical machines and appliances, cranes and all mechanisms operating port facilities. (d) Railway and track extensions and maintenance. Other technical departments are devoted to future schemes, designs, surveys, etc., and the remainder, besides general administration, are concerned with records, staff, workmen, estate management, etc.

Shipbuilding and ship repair departments are under separate direction. The General Manager and Port Director is Mr. Ernst Plate.

Trading Countries.

In the years between 1920 and 1939 the average total traffic in the port of Hamburg was no less than 22 million tons, reaching its peak in 1929 with 29 million tons. Now all, or almost all, the incoming and outgoing river and rail traffic to Eastern Europe countries and the portion of Germany beyond the iron curtain is cut off. In spite of this the tonnage handled is growing substantially, and in 1950 passed the 10 million tons mark. In pre-war years the river traffic reached the high total of over 6 million tons, arrivals and despatch being about equal. The imports from overseas were about 12 million tons, and the exports 7 million tons. The arrivals by rail totalled 8 million tons, and the goods despatched inland by rail reached nearly 3 million tons. The best customer in both directions was Great Britain, representing about 15-21 per cent. of the trade of the port. The next best trading countries were the United States, Java and India, Argentine and the hinterland of Germany, Czechoslovakia and Poland.

The Elbe Approach.

The approach to Hamburg from the North Sea is indicated by the three Elbe lightships, 1, 2, 3, leading into the estuary near to the small advance port of Cuxhaven, where the Elbe estuary is about 12 miles wide. The pilots for the Kiel Canal passage to the Baltic and for the navigation to Hamburg are picked up or dropped at Cuxhaven. The mean tidal range at Cuxhaven is 9.5 feet, whilst at Hamburg it is 7.2 feet. The length of the navigable channel from the mouth to the Elbe Bridges is 67 miles. In periods of river flood the velocity of the current reaches a maximum of 6 knots, and besides the added hazard to navigation, often occasions considerable shifts of bed sand.

Experiments conducted by Dr. Weiner Boos[1] show that in the estuary a few miles east of Cuxhaven the greatest intensity of the flood current reaches its peak between 3—3.5 hours before high water, and on the ebb remains steady between 5—7 hours after high water. In this connection the study of the salt content of the Elbe by Professor Dr. Walter Henson[2] shows that the boundary of the brackish water area lies about 32 miles west of Hamburg and 35 miles east of Cuxhaven, and to quote Dr. Van Veen of the Dutch Rijkwaterstaat, "where a drop of salt water may go, so also can a grain of sand". In fact, the reduction of the salt water invasion of the estuary assists considerably the maintenance of the channel depths.

The expense of maintaining the depth of navigable channel and the aids to navigation of the Lower Elbe prior to 1920 was borne by the port of Hamburg. Now it is a Federal State responsibility. Hamburg[3] sprawls over a considerable length of the river and that part of it in the port zone is cared for by its own organisation. For example, measured in the mid-channel there are 8½ miles of waterway and 115 miles of waterfront, some walled and some reveted. At the Elbe bridges the river is 850-ft. wide and immediately downstream of the fish dock it is 1,500-ft. wide. At mean high water there is 40-ft. depth of water in the main channel, and in the docks 24—36-ft. depth at high water, the tidal range is 7.2-ft. mean. The overseas docks have over 20 miles total length

The Port of Hamburg—continued

of quay walls, the free port about 18½ miles, and the river docks or internal traffic docks 10 miles of quay walls. The extensive ranks of dolphin moorings cover about 44 miles run, of which nearly half are for sea-going vessels. The total length of the waterfronts reaches the formidable figure of 115 miles, of which a proportion is simply reveted.

Considering that the total area of the port which contains these large amounts of engineering structures, mostly founded in relatively deep water, is only 10,000 acres, it will be appreciated that there is a high concentration of commercial and industrial activity. The island of Wilhelmsburg has been carved, or rather, dredged out to form a tightly packed series of docks, waterways and industrial areas, which is linked with the mainland by five main bridges only. The low deck levels of the North Elbe bridges restrict the traffic up river, to the east, to river craft only. The water areas of the port and river docks amount to 3,250 and 850 acres respectively, about 50 per cent. of the former figure being devoted to the free port. At first sight one has the impression that the separation, as it occurs, between the sea-going harbour and the river port is awkward—in fact, the whole arrangement of the Hamburg Commercial layout seems to have that quality—nevertheless in actual operation, matters adjust themselves so naturally this acquiescence in the status quo reduces theoretical arguments to zero. It is the human element which counts. Hamburgers have grown up with their port development and have found it satisfactory.

However, it should be appreciated that the port directors are gradually remodelling the layout: there is a constant research being carried out in design, convenience, economy and safety by Strom and Hafenbau experts. Regarding the present day problems of quayside and shed handling of goods with the assistance of heavy lorry transport, Dr. Gunter Krauss[1] remarks that one must not distrust new means or methods: the old experience gained from the invasion of railways into port work should be the yard stick to guide adjustment and use. Everything necessary to accelerate land traffic circulation is as equally important as that of vessels' turn round. Both require keen planning for efficient development.

Mooring Dolphins.

In North Western Europe mooring dolphins are an important feature of all waterways and Hamburg, like other large ports, where much loading from, and discharging into river craft takes place either from seagoing vessels directly, or indirectly from sheds, has developed its own method of moorings and also its individual type of construction. In Great Britain floating buoys securely anchored in the river or harbour at distances apart which allow of fore and aft mooring are mostly used, and dolphins are more frequently employed as wharf extensions or " lead-in " wait moorings to a tidal or dry dock. In Holland also, fore and aft moorings are used for loading and unloading berths, but in place of buoys the preference is for sturdy timber dolphins. Hamburg, too, prefers dolphins, of which there are no fewer than 9,000, providing moorings of a total length of about 44 miles.

An interesting feature of a great many of these dolphin series is that they are so placed as to give use on two sides and, together with the springs and fore and aft mooring ropes, a virtual all-round working use. These Hamburg dolphins are spaced closer than is usual elsewhere (Figs. 1 and 2) so that a vessel may lie alongside of at least two, and have mooring springs, head and stern ropes attached as shown. In the slight tidal range it is obvious that this method is more secure and quiet than those mentioned above; and has a greater relative security in busy waters.

The old Hamburg type was a system of eight natural timber piles raked about 1 in 8, two per side, stoutly braced near L.W. level with squared timbers, and also, at the head, just above high water, for the lighter traffic. For large vessels sixteen piles are used (Fig. 2b), half of them arranged as for the lighter construction and the remaining eight driven two per side outside of the former and carried up to a higher level ending at a top bracing about the same distance above the middle bracing as the lower is below. For this purpose the bracing timbers of the lower two are connected to all sixteen piles, whereas at the top the outer eight piles only are bolted (as shown in photograph) to the cross bracing. It will be readily noted that the protruding chain mooring links are placed at the corners of the centre bracing. This is actually for the convenience of mooring of the smaller vessels. It will also be noted that the outer piles show signs of wear for about 4-ft. above the water line.

Deflection of Dolphins.

On the whole there is a lot to be said in favour of timber dolphins. They show good performance, particularly in busy ports like Hamburg. Other ports, i.e., Rotterdam and Bordeaux, have developed in the generations of their growth particular designs of their own: the former more sturdily built of steeper rake with sawn timber, and the latter a lighter natural timber group of 4 to 6 piles braced at water level and free at the top.

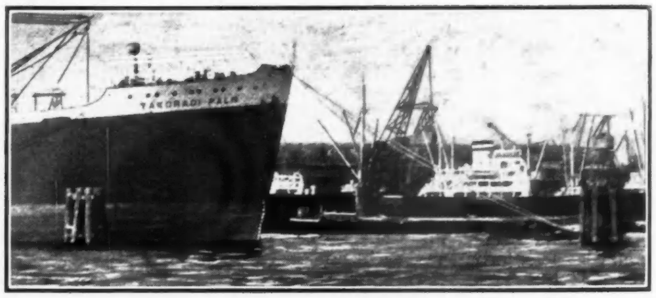

Fig. 1. Timber mooring dolphins for sea-going vessels.

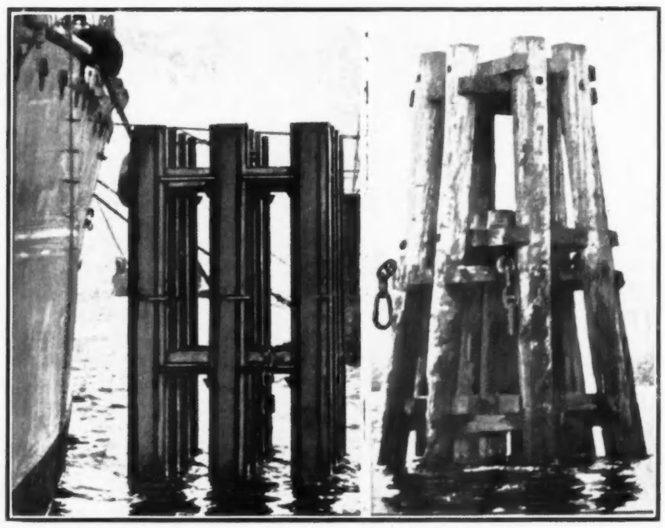

Fig. 2 (a) Recent steel box pile dolphin: note the disadvantage of unfendered tops of vertical piles when situated under the flare of large vessels ; (b) Timber dolphin of the usual Hamburg pattern.

Whilst there are differences of opinion in Hamburg engineering circles, as elsewhere, regarding the bracing of dolphins and fenders in general, Oberbaurat Dr. Kurt Förster[3] has pointed out that the give, or spring-like deflection, of a dolphin under the impact blow from a vessel tends to ensure the safety of both. He also points out that cross bracing is frequently too rigid, decreasing the amount of give and, therefore, increasing the intensity of the blow but, nevertheless, resulting in lesser energy absorption. It was appreciation of this fact that led to the invention of articulated systems allowing of considerable movement such as the Simec, Baker, Blum, Minnich and Reiner fenders. Recently, or rather within the last two decades, much attention has been paid to the elastic spring value of unbraced dolphin members. Although the blow is the lesser in amount at the point in the length of maximum deflection, the work done diagram is greater in value than for a blow at any other point in the length for equal fibre stresses in the member. In other words, the amount of work done in bending a

The Port of Hamburg—continued

pile by the application of a horizontal force at any point in its length to cause an equal fibre stress in the pile varies directly as the effective lengths of the respective cantilever arms; for example, if at half height of a pile the work done by a force F is A inch-pounds, then for a force nF applied at full height to produce an equal amount of bending moment the work done will be 2A inch-pounds. The Reimer and Minnich systems are based on this fact.

It is undeniable that timber dolphins designed carefully and provided with expendable parts for wear and tear which are readily repaired or replaced give efficient service. It is also well known that timber constructions such as, say, the New York jetties are so elastic that even when damaged considerably by collision, the vessel causing it frequently escapes with damaged paintwork only. A few years ago the Queen Mary in a gale of wind, when mooring in charge of tugs, caused a large amount of damage at Southampton leading in jetty without appreciable mishap to herself.

Fig. 3. Grossenbrode train ferry berth of dolphin groups.

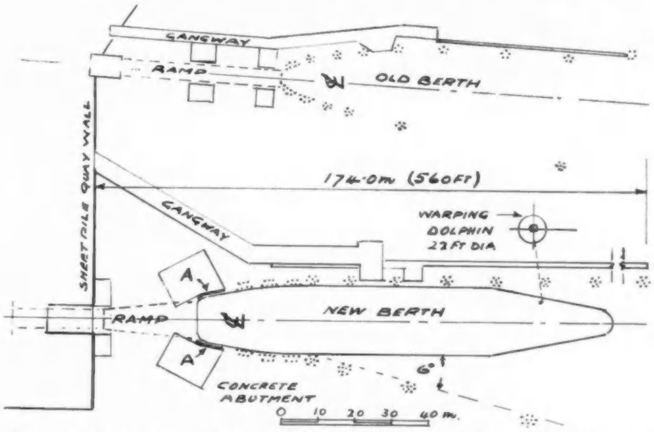

Fig. 4. Train ferry berths at Grossenbrode. A, steel impact fenders with spring shock absorbers.

Steel Dolphins.

Latterly there has been a tendency in Hamburg to install steel dolphins of various types. There are advocates for and against this change; nevertheless quite a large number have been installed with box pile sections, rolled steel joists, especially fabricated tubular pile sections, and plain flat pile sections; Larssen, Mannesmann, Rheinhausen and Belval type sections. Undoubtedly a strong challenge has been made by steel construction and it is yet too early to decide what the outcome will be. Competent Hamburg engineers are investigating the various designs, comparing the results to the long and extensive experience with timber construction.

Most of the steel pile members are driven vertically in groups of three, six, nine and twelve, some are braced at one level only, near the top or, as in the Fishery Harbour, about 2 metres above average water level; others are braced at two levels, one near the heads and one between that and water level. The bracing takes the form of flat steel decking reinforced with suitable rolled sections—in some cases, this decking is fabricated from a single plate which threads over the tops of the piles and held in place on brackets welded to piles. It is debatable[6] whether this bracing should be rigidly fixed to some of the piles or whether there should be provided connections with an element of articulation. The buckling danger to a steel pile section is also a factor of consideration in choice of section. One notes, too, in many cases, the bareness of the pile heads and the lack of chafing or rubbing members. (See Fig. 2a.)

It is to be expected that the extensive use of dolphins in Hamburg and in the waterways of the region would encourage development and invention besides producing specialization in construction. One particular form in wide use in recent years is fabricated with Mannesmann tubes by the Hamburg firm of that name. Figs. 3 and 4 show the leading-in ranks of dolphins to the old berth of the Grossenbrode train ferry. This is not in Hamburg but is closely associated with it, and moreover has a topical interest in view of the new construction of a like nature at Dover[7]. On the right, the mooring side, there are seven groups of dolphins each formed of six tube piles, five of which are placed at corners of a polygon, two of them parallel to the hull of the ferry, and one central tube pile with the white capping. The first three groups to seaward are about 16.0 m. spacing, the next spacings are about 12.0, 8.0, 6.0 and 6.0 m. The last dolphin next the bridge ramp is of 7 piles placed in the form of a lemon slice with 4 piles on contact side with the vessel's belt. On the off side there are four groups of piles, two of the lemon slice pattern and two polygonal type of 6 piles which are placed symmetrical about the centre line of vessel with contacting faces of the same form in plan as the belt of the ferry. Two other 6 pile dolphins are placed at wide spacings at an oblique line to berth axis.

The new 5,000 ton train ferry, "Deutschland," the most modern of the class coming into service on this run, necessitated heavier construction than the above. For this reason a second ferry berth was constructed and completed only this year. The main points of difference between the new and the old are: berth stern first and three lines of track at the junction of ramp and vessel; heavy mass concrete abutments at end of ramp provided with a steel cushion (see A Fig. 4) of fabricated sections and buffer springs contacting the vessel's belt on a partial round of the stern, mostly to the side and not directly opposed.

To support the action of the end buffers there are on each side three dolphins of the lemon slice pattern of tubular piles, four of which are placed to contact the vessel's chafing riband. Eight metres seaward of these on the mooring side, there is an eight pile dolphin with 6 of the tubes driven at the corners of a hexagon and 2 in the enclosed area. On the off side (starboard) the opposite dolphin is a group of 10 tubes, seven of which are placed at the corners of a septagon and three internally. From this there are three similar dolphins driven in line obliquely diverging from the axis of the berth at wide spacing. On the other bow there are 9 dolphin groups of hexagonal pattern spaced approximately at 12.0 m. apart.

A point of particular note is that the welded plate bracings of the old berth were in one plane only, near the top, whereas in the new there are two, one at the top of the tubes and the other 3.0 m. below, thus giving an element of fixture. The warping dolphin placed outside the port side line of dolphins is 6.80 m. diameter and is designed for a pull of 60 tons. Another feature of interest is that with the welded purpose-made plate bracing the front piles taking the shock fit closely around the tubes, but the rear piles have a clearance of about 4-in. The bracings are supported in position on brackets secured to the piles.

Fish Dock.

The new fish dock lies on the north Elbe at Altona almost opposite the entrance to the Kohlbrand channel on the south bank.

The Port of Hamburg—continued

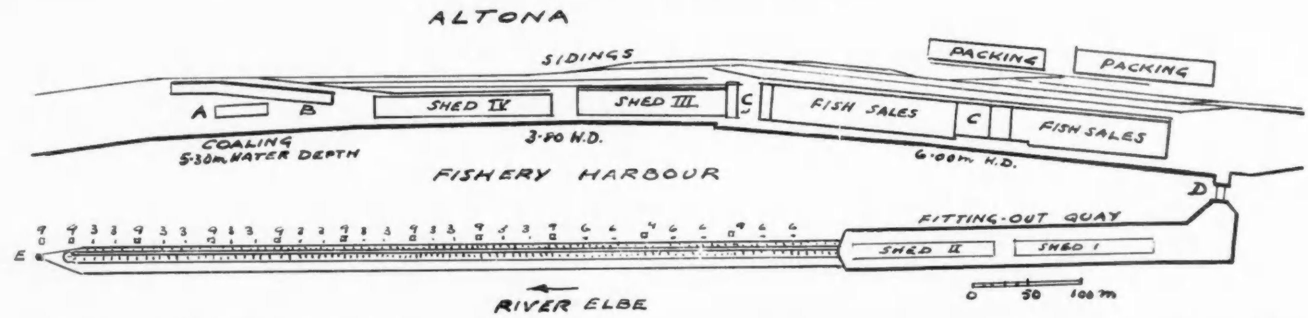

Fig. 5. Plan of Hamburg-Altona Fish Dock: numbers alongside dyke refer to the piles in the dolphin groups. D is upstream sluice gate and bridge, E is entrance light.

There was formerly a narrow straight dyke 3,200-ft. long lying out in the river separating a stretch of water about 350-ft. wide from the main stream. The river bank was slightly concave, narrowing to about 150-ft. at the eastern end (upstream). Almost all this area has now been reconstructed and modernised. Dr. Karl Eduard Nauman[8], however, points out that the present disposition is to serve the immediate needs so long as Germany is divided. But should the East become again open there is little doubt that the fishing fleet will increase in numbers as well as in the size of vessel using the dock. In view of that event, provision has been made for suitable extension.

The old dyke has now been reconditioned and reinforced, and on the harbour side has been liberally fitted with mooring dolphins for a length of 2,270-ft. The dolphins are of three types, 9, 6 and 3 pile groups. There are three of the 9 pile group placed close together at the downstream end (Fig. 5), and from there to the fitting-out quay they are spaced at about 200-ft. apart. For seven bays from the end, two (3-pile) groups are spaced evenly in each bay, and from there two (6-pile) groups are spaced evenly in the remaining bays. The latter are of the Wedekind type with flat plate bracings about 2 metres above average water level, with free tops 3-4 metres higher. The mooring chains are fitted to the plates.

The upstream end of the dyke for about one-third of its total length has been converted into a fitting-out and provisioning quay for trawlers. It is generally 100-ft. wide (Fig. 6) and has, on the harbour side, 6.70 m. (22-ft.) draught of water at mean water level. This quay has been formed by enclosing the dyke with steel sheet piles 60—65-ft. long with M.S. tie bars at 14-ft. below the deck level stretching from one side to the other of the wall. The piles are battered at 1 : 6 from the vertical and the top ends are encased in a sturdy R.C. cap beam. The fill is dredged sand, finished off with hard core road bottoming and cobbled surface.

At the extreme head of the upstream end there is a bluff spur on the harbour side. Here the steel piles are vertical and are tied back to concrete anchor walls. Between the tip of the spur and the opposing spur from the river bank a bridge is constructed over the narrow channel in which sluice gates are fitted. These are for the purpose of controlling the flow through the fishery harbour to prevent the deposit of mud, to reduce the flow of strong currents, and to avoid stagnant water.

On this quay two sheds, each 40-ft. wide and 400-ft. long, for the use of trawler owners and associated suppliers, are constructed. Bunkering facilities for steam vessels are provided on the north bank, near the fishery harbour entrance, where the draught of water alongside is 18-ft. at low water.

A large amount of reconstruction has been recently completed on this bank. Upstream from the bunkering wharf there are now 6 large sheds, as well as administrative offices, commercial and industrial accommodation, restaurants, and wash houses for employees in the fishing industry.

The quay walls have been renewed for a considerable length by driving steel sheeting in front of the old wall, with ties to anchor wall in the rear, and capped by a sturdy L-shaped R.C. wall to coping. Timber fenders are spaced about 15 m. centres with sunken quay ladders about 30 m. apart. There is 20-ft. depth of water at the fish discharging quay and two large fish auction sheds

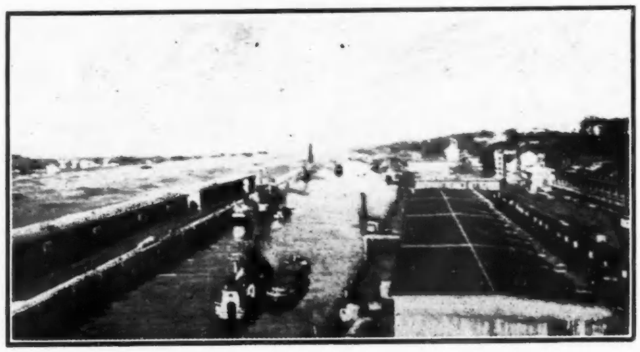

Fig. 6. Fish dock looking west.

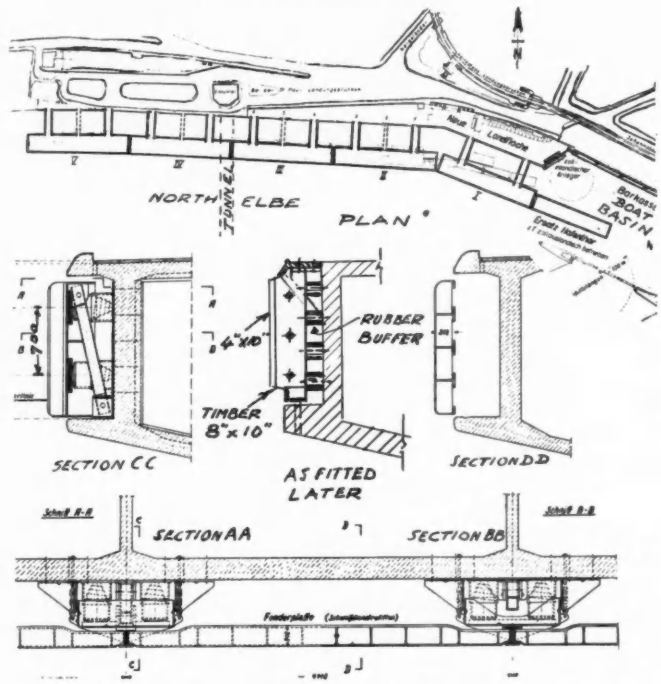

Fig. 7. St. Pauli ferry landing stage and sections of mooring fenders. neue landfläche = reclaimed land.

having a combined floor area of 4,840 square metres. Formerly the old building (No. 1) had a longitudinal partition wall separating the quayside auction room from the despatch and packing room on the Great Elbe Street side of the shed. The latter accommodation was too narrow and insufficient, and now on the north side of Great Elbe Street two large packing and despatch sheds have been erected, served by road and rail transport. The ground area to accommodate these has been achieved by excavating the hillside, demolishing old buildings and erecting a stout retaining wall of anchored steel sheet piling capped with a sturdy R.C. beam.

The packing sheds have basements and two floors; Shed No. XII

The Port of Hamburg—*continued*

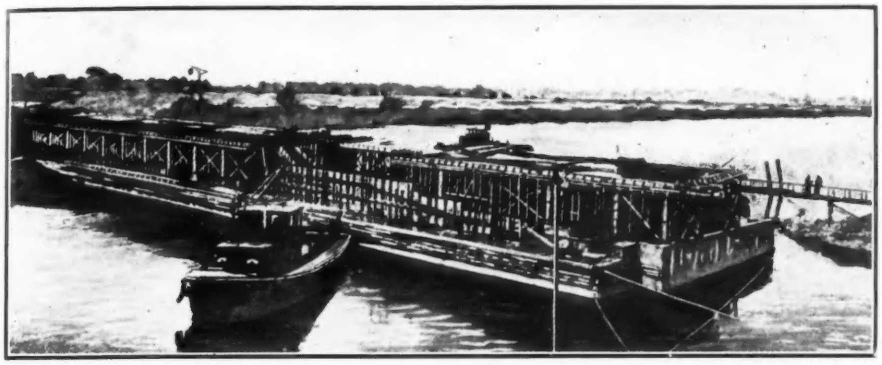

Fig. 8. Landing stage pontoon being drawn out of construction basin by tugs: rear view, note the recess in the rear corner for the 3.0 m. wide guide dolphins on site, and the ledge deck for light boat passenger traffic.

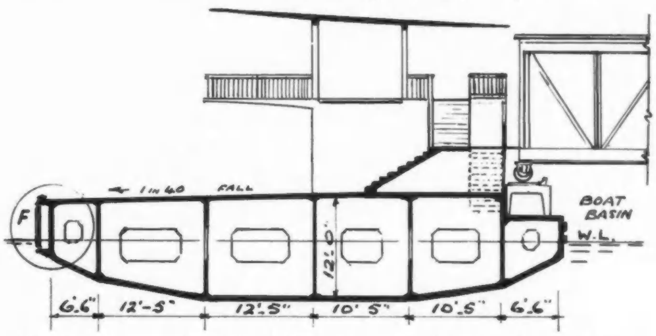

Fig. 9. Cross section of reinforced concrete landing stage pontoon.

has 700 sq. m. basement, 1,000 sq. m. ground floor, 800 sq. m. first floor; whilst Shed No. XIII has 1,050 sq. m., 1,500 sq. m., 1,210 sq. m. respectively.

Landing Stages.

A short distance upstream of the fishery harbour, on the right bank of the North Elbe and near to the Elbe tunnel shaft, there is the well known ferry landing station at St. Pauli (Landungsbrucken). Built in 1910, almost entirely of steelwork with timber furnishings, it extended in a straight run up the river for nearly 500 m., about 40-70 m. from the convex curved quay wall. It was supported on a large number of mild steel pontoons 6 m. wide, 2 m. deep and 20 m. long, placed transversally to the run of the stage. On the top deck of these floating tanks specially designed chairs supported the steel beams carrying the decking. The pontoons were arranged in twin sets at 18 m. centres, in which the pairs were spaced at 7 m. centres, thus forming in plan a series of alternate gaps of 1 m. and 5 m. respectively between the sides. This arrangement allowed flexibility of flotation and facility of repair and maintenance. It had given good service until destroyed.

The new construction differed considerably from the old[9]. In the first place, it involved reclaiming from the river the portion shown hatched in plan (Fig. 7), thus increasing the area of the embankment. This necessarily included a new quay wall. In front of this five new floating landing-stages, each 120 m. long, and each served by two foot bridges, were to be moored. When the scheme was approved it was intended that the floating units should be of reinforced concrete pontoons 18.0 m. breadth, 3.8 m. depth, and 60.0 m. long: a pair of units forming a stage. At 2.0 m. draught this represents about 2,000 tons displacement, already a formidable manufacturing problem. However, in the preliminary preparations the collaboration of two experienced firms of constructors, Messrs. Dyckerhoff and Widmann, and Phillipp Holzmann, the availability of a suitable area to serve as construction dry dock abutting on a wide channel (Reiherstieg) as well as a convenient fitting-out mooring, and the assistance of the Strom und Hafenbau made it possible to increase the length of units to 120.0 m. each. Considering that the depth between deck and bottom skin is only one-fortieth of the length, the boldness and ability of the engineers is apparent. Fig. 8 shows the hull leaving, in charge of tugs, the dry dock for the fitting-out moorings at the head of the Hansa dock.

The cross-section of the pontoon (Fig. 9) shows the cellular construction with freeboard of 1.43 m. (4-ft. 7-in.) at the ferry mooring side and 1.00 m. (3.28 ft.) at the landside. The footbridges linking with the quay rest on tracked rollers rocking on a chair secured to the ledge below the main deck level, which is 2.0 m. wide and is so constructed as to be suitable for the use of small boat passenger traffic. The spacing of the transverse ribs of the hull is 4.12 m. with longitudinal intercostals spaced as shown: three of the latter are solid, the central and the outer skins. Every fourth transverse rib is a solid bulkhead, whilst the others have lightening openings.

Fenders.

At the ferry mooring side the shell carries a projecting lip of concrete at the bottom, F., to provide a bottom support for the protecting fenders. The actual section as fitted is shown centrally (Fig. 7), whereas the original intention was to fit fenders of welded steel as shown by the other sections. The high price of these, more than double those adopted, brought about the change. As the central cross section shows, the fenders in use are of 8-in. x 10-in. timber baulks bolted together in pairs with 4-in. thickness of rubbing strips. On the back of each baulk there are four circular rubber buffers about 6-in. long and 6-in. diameter, which for 7 cm. compression is equivalent to 2.25 tons/m of work done (90-in. tons). The design allowance for the blow was assumed at 65 tons maximum. The bottom end of each pair of baulks is held in an angle iron secured to the concrete lip, and at the top by a malleable steel moulding runner secured to the top flange of a mild steel bracket plate fixed to the concrete shell. This bracket plate also serves as lateral guide to the fender units.

Reinforced Concrete Pontoons.

During the war, Hamburg found that the reinforced concrete floating pontoon was an economical and convenient structure for various and several uses in a busy harbour concerned with a large traffic with inland waterways. Besides this, a ceaseless passenger coming and going between the residential and commercial city and industrial areas of the riverside caused a great demand for these handy and relatively cheap hulks as aids for landing as well as goods carrying, piling hulks, construction depots, etc. In fact, the demands increased to the extent that one well known Hamburg firm, Dyckerhoff and Widmann[10], standardized sizes and types and developed expert methods of construction and launching. The simplest form was rectangular in plan, 30 m. by 6 m. wide, with a cross section almost rectangular with the exception of the bottom, which is rounded at a radius of 10 m.; the maximum depth was 3.25 m. on centre line and the freeboard was 1.50 m. The thickness of the walls and deck was 12 cms. In the length there were four solid bulkheads 15 cm. thick, dividing the hulk into five watertight chambers 6 m. long. In each of these compartments the side walls were further reinforced with vertical stiffeners 12 cm. thick, 80 cm.

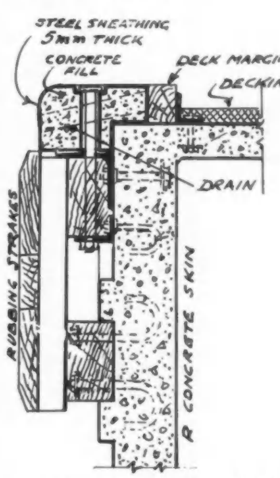

Fig. 10. R.C. pontoon fenders.

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Water Pollution Research 1954

The annual report of the Water Pollution Research Board and of the Director of Research includes an account of the new laboratory in Stevenage, which was occupied during the year. Progress made in the survey of the Thames estuary and in investigations on the effect of pollution on fish is described and also work on the treatment of water, sewage, and industrial waste waters.

The Survey of the Thames Estuary.

The survey of the Thames Estuary has proved to be of great complexity, and during the past few years a large proportion of the staff of the Laboratory has been engaged in this work.

The factors which determine the balance of oxygen in the estuary water have been closely studied, and it appears that two of the most important on the credit side are the flow of fresh water into the head of the estuary at Teddington, and the rate of absorption of oxygen from the air. It is estimated, for example, that the atmosphere contributes daily something like 1,500 tons of oxygen to the water in the estuary. This oxygen is used up in oxidising polluting matter discharged to the estuary, and a method of calculating the rate at which this occurs is described. Field investigations and experimental work have now been brought to an end and the lengthy calculations necessary before final conclusions can be drawn are in progress.

The Detergent Problems.

Three lines of enquiry arising from the increasing use of synthetic detergents in households and industry are being followed at the Laboratory. The work on the effect of these materials on sewage treatment has so far been inconclusive. The other lines of enquiry are concerned with the effects of detergents discharged to streams. It has been found that these may reduce the rate at which oxygen is absorbed from the atmosphere and so may delay the rate of recovery of a polluted stream, and also that they are appreciably toxic to fish.

Effects of Pollution on Fish.

Most of the work on fish carried out by the Laboratory during the year was related to a survey of the behaviour of fish in the River Colne, Herts, being made by the Ministry of Agriculture and Fisheries. At some times of the year very large numbers of fish were found in the channel through which undiluted effluent flows from the Maple Lodge sewage works to the river. Dead fish were seldom found although at times fish confined in boxes or traps in certain parts of the channel were killed. The Laboratory is attempting to correlate these results with chemical conditions in the channel. It is clear that the major factor causing death of confined fish was deficiency of oxygen, but the effect of this was probably enhanced, at least on some occasions, by the presence of direct poisons. These may include ammonia, carbon dioxide, and synthetic detergents; experiments on the degree of toxicity of these substances are being made in the Laboratory.

Treatment of Sewage.

Examination of the quality of surface run-off water from a large modern housing estate at Oxhey, Hertfordshire, showed that the water had a high content of suspended solid matter but that otherwise it was not very polluting in character.

The results of experiments with large and small percolating filters at Minworth, Birmingham, and with small filters at Finham, Coventry, confirmed that the length of the period between applications of doses of sewage which is, of course, determined by the rate of travel of the distributor, has a considerable effect on the efficiency of a filter.

Industrial Waste Waters.

It was reported last year that some cyanides could be destroyed by biological action in a percolating filter; the organism responsible has now been isolated and has been found to be an Actinomycete. To determine whether biological destruction would be a practical method for removing cyanide from mixed plating wastes, a filter was supplied with a solution of potassium cyanide and of the complex cyanides of the metals commonly plated from cyanide solution (zinc, cadmium, copper). The results were satisfactory, a concentration of 100 p.p.m. HCN being reduced to 3.3 p.p.m.

The results obtained in a pilot plant in which partially neutralised black liquor from kiering of cotton was digested anaerobically showed that this would be a possible method for pretreatment of the liquor before discharge to a public sewer. It was calculated that a digester would occupy less space than a percolating filter that would effect the same degree of purification; in addition no dilution of the liquor is necessary before digestion.

Automatic Equipment.

A section of the Laboratory is concerned with the development of equipment to assist the work of other sections. For example, an apparatus designed for recording continuously the concentration of dissolved oxygen in water was used in the survey of the River Colne. The apparatus, which is entirely automatic, draws a sample of water from the river every 10 minutes, determines the content of oxygen in the sample by a chemical method, and records the result on a chart.

" Water Pollution Research 1954 " is published for the D.S.I.R. by H.M.S.O., price 3s. (75 cents U.S.A.) by post 3s. 2d.

Port Facilities at Stettin.

It is reported from Berlin that the East German Government has ordered reconstruction work to start on the port of Stettin, which East Germany is to be allowed by Poland to use as a free port. The two countries agreed in March, that East Germany should be allowed to use the port for a fleet of ocean-going merchant vessels now under construction. It is understood that the first of these vessels, a 19,000-ton ship, is to be launched in the autumn. Stettin was formerly a German port but was placed under Polish control under the Potsdam Agreement.

The Port of Hamburg

(Continued from previous page)

wide, from bottom to deck. The bottom was ballasted with plain concrete later.

A large pontoon type is that used for ferry service VII, one of the busiest of the Elbe passenger traffic. A similar one is used for the overseas passenger landing stage. They are 92 m. (301-ft.) long, 17 m. (55.7-ft.) wide and 3.30 m. (10.8-ft.) deep, rectangular in cross section, and rectangular with swim ends in longitudinal section. There are 19 transverse bulkheads and five longitudinal; the outer skin is 14 cm. thick; the cross walls are 10-12 cm., bottom and deck are 12 cm. thick.

The fender protection for the side walls is shown in Fig. 10. It is to be noted that the securing hooks and bolts are cast in the concrete and do not pierce the hull, and that the cap beam of 3/16-in. steel sheeting is filled with concrete, and bolted down through two angle irons and timber riband. The latter supports the top of the short vertical timber plank ends, which are also secured at the bottom to a riband hook, bolted to the concrete. The hulk used for overseas liners' passenger landing stage usually lies on one side of a twelve-pile dolphin series, whilst the liner is berthed to the opposite side.

REFERENCES

1 Werner Boos. " Die Messung kleiner stromund geschwindigkeiten im wassenbanlichen Versuchswesen ".
2 Walter Hensen. " Das Eindringen von Salzwasser in die Gezeitenflüsse und ihre Nebenflüsse, in Seekanäle und in Hafen." Franzius-Institut Hanover, 1953.
3 Ernst Plate, " The Port of Hamburg ". " Dock & Harbour Authority," No. 394, Vol. XXXIV/53.
4 Gunter Krauss, " Die Abfertigang von Lastkraftwagen an Kaischuppen "; " Hansa " Nos. 1/2, 1951.
5 Kurt Förster. " Schiff und Dalben ", " Schiff und Hafen ", No. 9, 1951, p. 300.
6 Baudirektor Wedekind " Stability of Dolphins ", " Schiff und Hafen ", No. 1, 1952, p. 31.
7 " Dock & Harbour Authority "—" Dover Car Ferry Terminal ", No. 392, Vol. XXXIV, 1953, p. 35.
8 Karl E. Naumann, " Der Wiederaufban des Fischereihafens Hamburg-Attona ", " Hansa " Nos. 33/34, 1952.
9 Kurt Förster, " Die St. Pauli-Landungsbrücken ", " Schiff und Hafen ", No. 9, 1952, p. 331.
10 F. Sulz, " Reinforced Concrete Pontoons in Port-work ", " Hansa ", Nos. 38/39, 1952.

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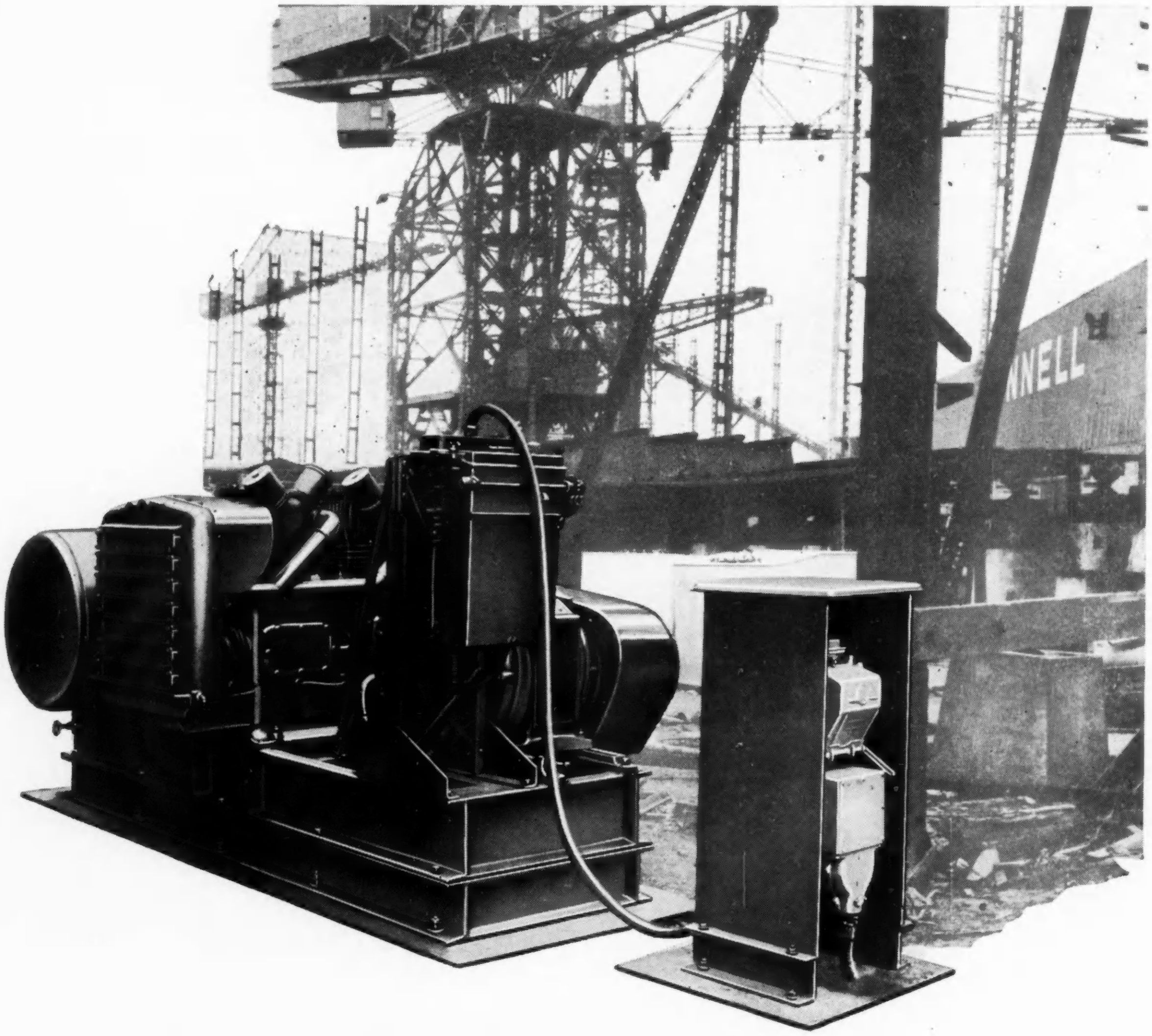

NNELL

A Berthing Beam for Large Vessels

New Design at Jamaica and Singapore

By H. RIDEHALGH, M.I.C.E.

THE provision of alongside berths for large vessels at a low capital cost has always presented a major problem to the Civil Engineer and is one which has become accentuated in recent years due to the continued increase in the carrying capacity of oil tankers.

Such vessels are now being built with a deadweight capacity of 45,000 tons and more, equivalent to a displacement of about 59,000 tons with a laden draught of 36-ft., and the fact that their cargoes are invariably drawn from undeveloped areas and delivered to sites remote from main dock systems means that special berthing facilities have to be provided.

This article deals primarily with the means of meeting such demands although there is no reason why the solution put forward can not be adapted for use in many new and existing berths by vessels of all types.

Existing Designs.

During the past few years economies have been achieved by building open structures equipped with energy absorbing fender systems, the most notable contributions being The Heysham Jetty,[1] the facilities at Mina al Ahmadi in the Persian Gulf[2] and the new jetty at Thames Haven[3].

At Heysham, in a very exposed berth, two bell type dolphins were used, these being joined by a piled jetty head on which were mounted pairs of vertically suspended gravity fenders.

Similarly, at Mina al Ahmadi, deep water berths were provided in the form of a steel piled structure which was also protected by groups of vertically suspended gravity fenders.

At Thames Haven there was a departure from previous practice in so far as the design was in prestressed reinforced concrete, the jetty head being carried by groups of cylinders laced together with prestressed beams from which were slung horizontally, three pairs of prestressed concrete swinging fenders.

Further examples of berths for large vessels are afforded by designs for Belfast and Sunderland both of which incorporated horizontally swinging concrete blocks.

The energy absorbing capacities of individual fenders of the various designs are recorded as being:

Heysham bells	160 tons feet.
Thames Haven fenders ...	90 ,, ,,
Mina al Ahmadi	85 ,, ,,
Heysham vertical fenders ...	75 ,, ,,
Belfast	37 ,, ,,
Sunderland	35 ,, ,,

Design Data.

It must be conceded that substantial progress has been made by the evolution of designs which permit vessels of upwards of 30,000 tons displacement to go alongside open structures under normal circumstances without damage to the jetty.

It is difficult however to define "normal circumstances" in terms of approach velocity but the writer would suggest, after having had the opportunity of witnessing and studying many reports of berthing operations, that the approach velocity (measured normal to the jetty) very rarely exceeds 1-ft. per second and is more often nearer 0.4-ft. per second. Further, approach velocity seems to vary inversely as the displacement.

An additional variant for which the writer has found some support in practice is that, other things being equal, the percentage energy absorbed by the structure falls with, but is not necessarily directly proportional to, a reduction of ship speed.

Considering vessels of 20,000 tons displacement as the lower limit and using the higher velocity figure of one foot per second, the kinetic energy to be absorbed is roughly 310 tons feet.

At the upper limit a 59,000 tons displacement vessel travelling at 0.59-ft. per second possesses the same energy. Such a speed is, if anything a little high for vessels of that size and it is considered therefore that the figure of 310 tons feet would be a maximum in "normal circumstances."

Designers usually reduce this maximum energy figure by from 30 per cent. to 50 per cent. to allow for deformation of the ship's hull, friction, length of lever arm to centre of gravity, and so on, leaving a much smaller total of energy to be absorbed by the fender system and the jetty itself.

In addition it has usually been assumed that the vessel will strike more than one fender at or immediately after the moment of initial impact which explains why units of such comparatively low capacity as are noted above can deal with fairly high total energy figures.

These then are what can be broadly described as "normal circumstances" during berthing and it has been freely stated that it is not economically possible to deal with the "abnormal" circumstance which falls into the accident class.

There are two extreme cases when there is no lever arm between the line of the resultant at the point of impact and the centre of gravity of the vessel. These are when the vessel berths broadside on and when the ship strikes the jetty "bows-on" or at an angle greater than about 45° to the face of the jetty.

The former case is the ideal for berthing where several individual or groups of fenders are brought into use at the same time and the latter is the "abnormal" case which is conveniently put into the accident class. In such a case the consequences usually are that the vessel completely misses the fenders, the jetty is badly damaged and goes out of service awaiting substantial expenditure on repairs and large sums of money are incurred in ship demurrage.

These cases are in fact however by no means infrequent and it is considered that whatever concessions are granted to the systems of energy absorbing fenders generally in vogue to-day there is a very great need for a fender which will protect the whole of the berthing face in emergency.

Reverting to the case of a vessel approaching within the "bows on" arc, the vessel is so very rigid in the direction of its longitudinal axis that there can be little reduction in energy to be absorbed by the jetty by deformation of the hull, frictional losses are enormously reduced and the lever arm is virtually nil. In consequence the percentage energy to be absorbed by fender and jetty is probably nearer to 90 per cent. of the total than to the more popular figure of 40 per cent. for normal conditions of berthing. In the case of a 20,000 ton vessel striking at 2-ft. per second the total energy would be 1,240 tons feet, of which something like 1,100 tons feet might have to be absorbed by the fender and jetty.

This is a formidable demand but is nevertheless an indication of the shortcomings of conventional fendering systems when the ship is temporarily out of control.

With these points in mind the problem of providing berths for the Shell Petroleum Company at Jamaica for tankers having a displacement of 24,000 tons and at Singapore for tankers of 59,000 tons displacement was considered.

Site Conditions.

The requirements, so far as the Oil Company was concerned, were that they should, at the very earliest date, be able to load and discharge oil as rapidly as possible in berths built at the lowest possible cost and on which there would be low maintenance expenditure. Furthermore there had to be some factor of safety over normal ship blow since vessels of 43,000 tons displacement would be required to go alongside at Singapore without the aid of tugs. The berths had also to be capable of taking tankers of up to 59,000 tons displacement berthed with the aid of tugs.

A typical cross section showing sea bed levels at one of the

[1] I.C.E. 1947/8 and "The Dock and Harbour Authority," Aug./Sept., 1948.
[2] I.C.E. 1951/2.
[3] "The Dock and Harbour Authority," November, 1952.

A Berthing Beam for Large Vessels—continued

berths is illustrated in Section D-D of Plan from which it will be seen that the bottom falls away steeply and it eventually flattens out in about ten fathoms of water. The requirement was for 42-ft. of water at low water which placed the face of the berths at Singapore between 350-ft. and 900-ft. offshore.

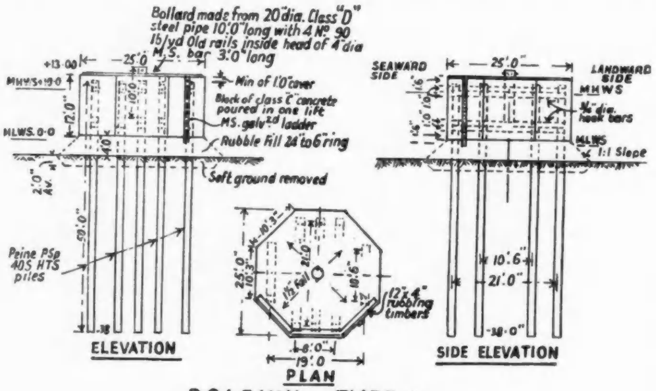
Maximum tidal range was of the order of 11-ft. and there was a maximum current of some three knots on springs running roughly parallel to the line of the berths.

Winds generally are off-shore and light but on occasions squalls of gale force blow from the north on to the berths.

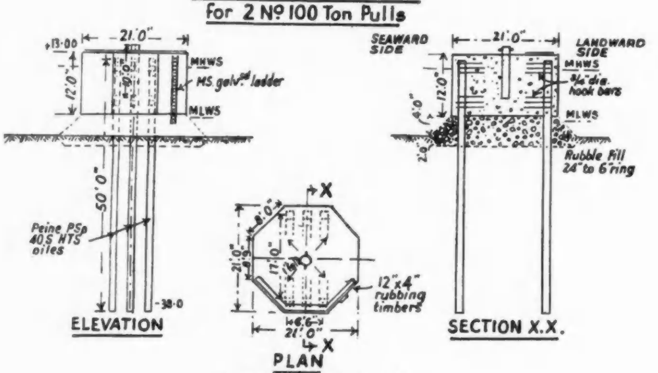
Possible Alternative Designs.

The design of the approach spans presented no problem in so far as the Oil Company had already evolved a design with which they were satisfied and which was adopted throughout.

The problem was therefore to provide jetty heads to the Company's requirements and with sufficient space ashore for hose handling equipment and berthing operations.



DOLPHIN - TYPE I.
For 2 No 100 Ton Pulls



DOLPHIN - TYPE 2.
For 1 No 100 Ton Pull

Alternative designs which were considered included a mass concrete gravity wall, flexible dolphins, reinforced concrete piled jetty head with suspended fenders swinging horizontally and vertically and reinforced concrete portal frames on heavy cylinders with swinging fenders. As a result it became clear that, apart from the dolphins, the designs would take too long to build and would prove much more expensive than was considered justifiable, which could be attributed largely to the need to cater for very considerable forces from ship blow acting at a height of some 60-ft. above sea bed. Further, only the mass concrete gravity wall would afford a fully fendered berthing face.

Dolphins of special design were shown to be acceptable economically but their inherent disadvantage of restricted alongside access and unsuitability for vessels of widely varying sizes resulted in their rejection except in the case of one berth which was urgently required. Dolphin berths of course also suffer from the additional disadvantage, that should one dolphin be seriously damaged then the berth would probably go out of service until repairs could be effected. The design of the berthing dolphins is illustrated on this page. Their cost in Singapore was £10,000 each and they each have a calculated energy absorption capacity of 163 feet tons. Their design is based on that of dolphins already in use at Pernis, Rotterdam and elsewhere.

Design Selected.

Having regard to the maximum energy figure of 310 tons feet previously suggested and a desire to give full protection throughout the length of the berthing face, together with the unsuitability of conventional designs, consideration was given to the use of a flexible structure, not merely to carry the fenders but to act as a fender itself.

Flexibility of the supports was fundamental and the higher the working stresses which could safely be used the cheaper the structure would be.

The use of high tensile steel in the Pernis type dolphins suggested an answer and if in addition some means could be devised of augmenting their already high working stresses then further economies might prove to be possible.

In the discussion on Mr. D. H. Little's paper " Some Designs for Flexible Fenders " read at the Institution of Civil Engineers in October, 1952, the present writer described what he then thought might offer a solution. Briefly it consisted of a row of raking high tensile steel piles driven along the line of the berth, laced together and loaded at their heads by a very rigid and heavy concrete beam which would give an initial forward deflection to the piles. The beam itself would provide the berthing face and when struck it was intended that it should distribute the blow to all the piles which would thereupon be pushed back from their forward deflected position, through their position of nil deflection to a position of maximum backwards deflection, at which point all the energy would have been absorbed. Fig. 3 shows an outline of the design which was the basis for the one ultimately selected for use in Singapore and in Jamaica. The length of 240-ft. for the berthing face was selected as being slightly in excess of the length of the straight portion of tankers likely to use the berths.

Design.

It was decided to use high tensile steel piles and in view of the previously proved efficiency of large Peine sections in dolphins, that type was adopted for Singapore although lighter British high tensile broad flanged beams were used in Jamaica. Two sections were selected, the properties of which are:

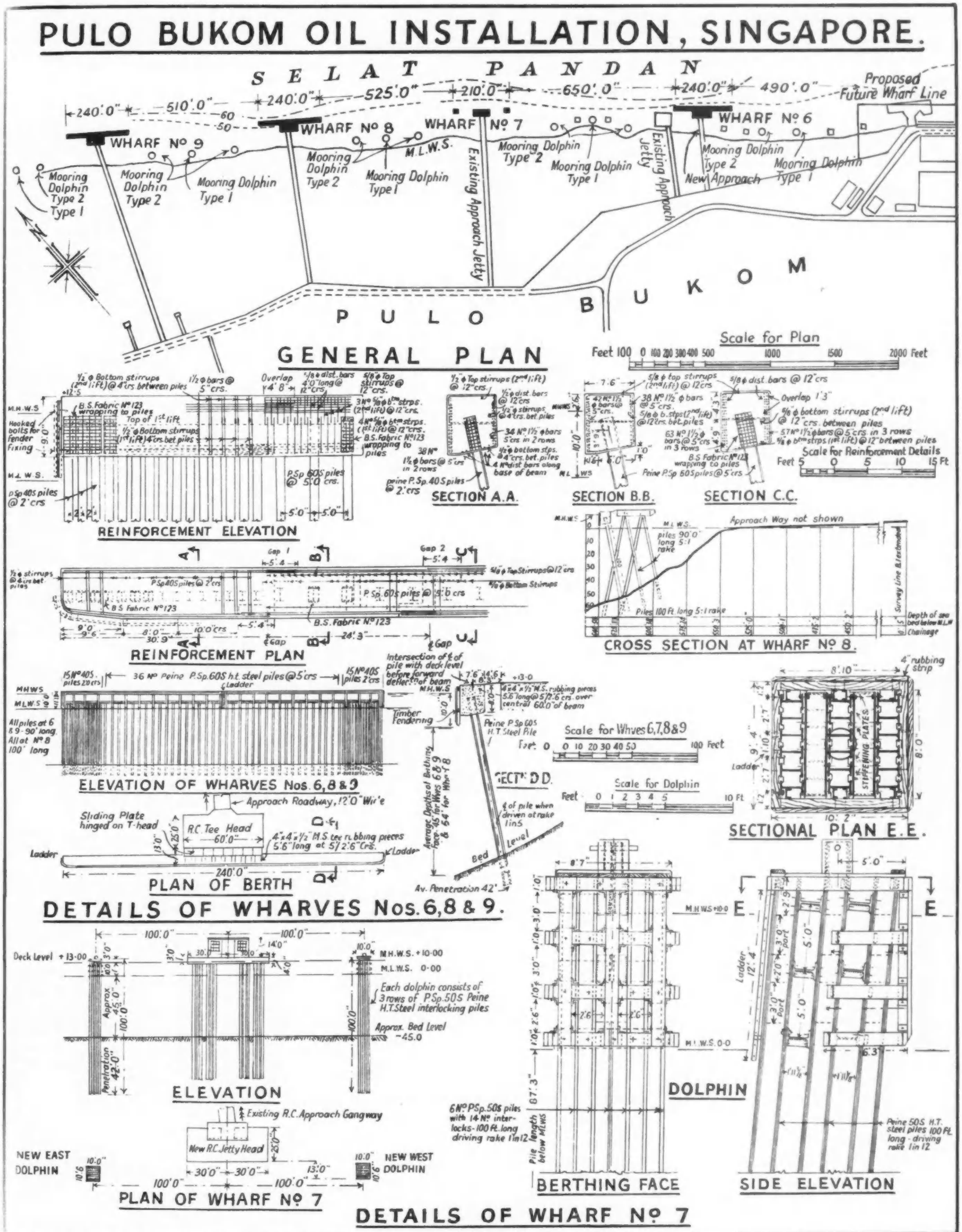
	P.Sp.40s.	P.Sp.60s.
Overall dimensions approx.	16-in. x 15-in.	$23\frac{1}{4}$-in. x 15-in.
Web thickness approx. ...	15/32-in.	15/32-in.
Flange thickness approx. ...	$\frac{5}{8}$-in.	21/32-in.
Moment of Inertia ...	1352.4-in.^{4}	3397.2-in.^{4}
Section Modulus	156.2-in.^{3}	270.3-in.^{3}
Weight/foot	94.1 lbs.	110.9 lbs.

Maximum bending stresses used in design were 22.8 tons per square inch under severest ship blow and up to 13.0 tons per square inch when the piles were deflected forward under dead load.

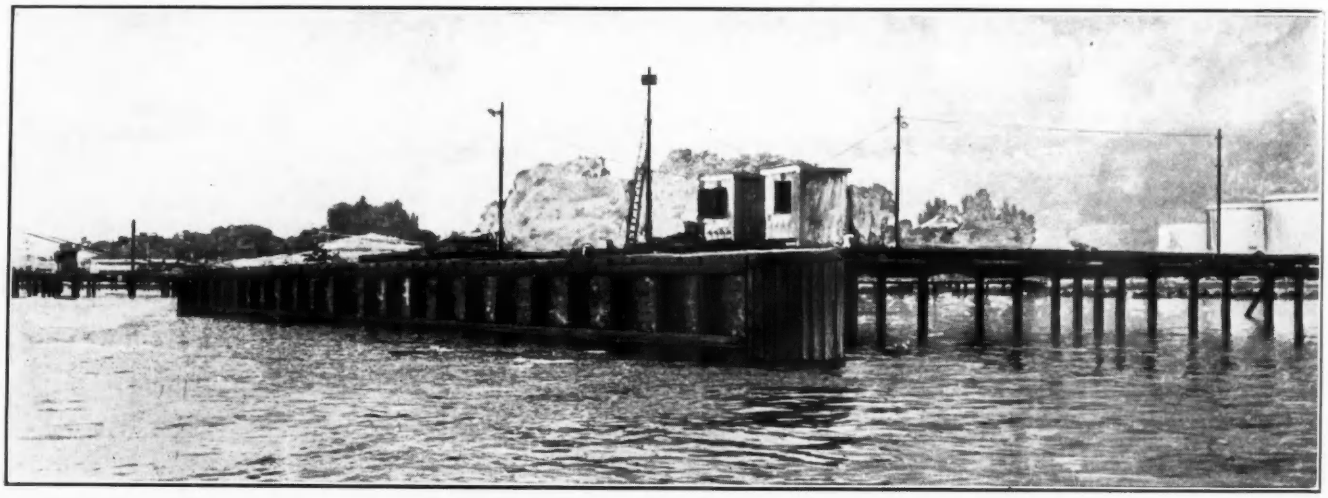
One of the assumptions made before attempting design was that the concrete beam lacing the heads of the piles together could be made sufficiently rigid to resist bending in itself and that, in consequence, it would transmit ship blow in linear ratios to the piles. Furthermore, it was assumed that if the beam were to receive a blow at one extremity it would retract at the end receiving the blow whilst the other extremity would move horizontally forward in the opposite direction. To accommodate this anticipated end forward deflection therefore, it was considered necessary to stress groups of piles at the ends of the beam to only 7.5 ton/sq. inch under dead load.

An essential feature of the design would be complete pile-toe fixity and it was assumed that this would be achieved by driving to refusal into very stiff clay at Singapore which was described as " approaching brick in hardness " or by adequate penetration into the silt and sand encountered at Jamaica.

It was also assumed for design purposes that the point of fixity of the piles as simple cantilevers would be 8-ft. below sea bed level giving an effective length of 58-ft. at Singapore. The selected rake was 1 in 5, the piles leaning outwards from the face of the berth, the P.Sp.40s. piles being spaced at 2-ft. centres over the end 30-ft. and the P.Sp.60s. at 5-ft. centres in the middle 180-ft.


PULO BUKOM OIL INSTALLATION, SINGAPORE.
SELAT PANDAN
Proposed Future Wharf Line
WHARF Nº 9
WHARF Nº 8
WHARF Nº 7
WHARF Nº 6
Mooring Dolphin Type 2
Mooring Dolphin Type 1
Existing Approach Jetty
Existing Approach Jetty
New Approach
PULO BUKOM
GENERAL PLAN
Scale for Plan
REINFORCEMENT ELEVATION
SECTION A.A.
SECTION B.B.
SECTION C.C.
Scale for Reinforcement Details
REINFORCEMENT PLAN
CROSS SECTION AT WHARF Nº 8.
Approach Way not shown
ELEVATION OF WHARVES Nos 6,8 & 9
Scale for Whves 6,7,8 & 9
SECT^N D.D.
Scale for Dolphin
SECTIONAL PLAN E.E.
PLAN OF BERTH
DETAILS OF WHARVES Nos. 6,8 & 9.
ELEVATION
Each dolphin consists of 3 rows of P.Sp.50S Peine H.T.Steel interlocking piles
Existing R.C. Approach Gangway
New R.C. Jetty Head
NEW EAST DOLPHIN
NEW WEST DOLPHIN
PLAN OF WHARF Nº 7
BERTHING FACE
DOLPHIN
SIDE ELEVATION
DETAILS OF WHARF Nº 7

A Berthing Beam for Large Vessels—continued



One of the berthing beams at Pulo Bukom, Singapore.

On these assumptions the loads which could be carried by the two types of piles at the selected spacing were calculated as follows: deflections being measured from the position of zero stress.

Piles P.Sp.40s.

Max. D.L. forward stress—7.5 tons/sq. inch.
Max. D.L.+L.L. forward and backward stress—22.8 Ton/sq. inch.

Tide	Dead load only		Dead plus live load			Dead plus live load		
	Forward Deflecn. ins.	D.L. Tons	Forward Deflecn. ins.	D.L. Tons	L.L. Tons	Backward Deflecn. ins.	D.L. Tons	L.L. Tons
L.W.	10.3	7.93	31.5	7.93	3.28	31.5	7.93	6.45
H.W.	6.75	5.25	31.5	5.25	3.94	31.5	5.25	6.04

Piles P.Sp.60s.

Max. D.L. forward stress—13 tons/sq. inch.
Max. D.L.+L.L. forward and backward stress—22.8 tons/sq. inch.

Tide	Dead load only		Dead plus live load			Dead plus live load		
	Forward Deflecn. ins.	D.L. Tons	Forward Deflecn. ins.	D.L. Tons	L.L. Tons	Backward Deflecn. ins	D.L. Tons	L.L. Tons
L.W.	12.5	23.3	21.8	23.3	3.62	21.8	23.3	13.0
H.W.	7.5	14.0	21.8	14.0	5.78	21.8	14.0	11.4

These figures show that the piles could carry the following horizontal loads transmitted per foot of beam under various tidal conditions and at the spacing selected.

Pile	Low Water		High Water	
	Forward	Backward	Forward	Backward
P.40.s	1.64 tons.	3.22 tons.	1.97 tons.	3.02 tons.
P.60.s	0.72 tons.	2.60 tons.	1.16 tons.	2.30 tons.

From the above can be calculated the forces which can be resisted were the beam to be struck at one end and these are:

At Low Water — 193 tons, deflection 10.3-in. + 31.5-in. = 41.8-in.

At High Water — 181 tons, deflection 6.8-in. + 31.5-in. = 38.3-in.

The minimum capacity of the beam to absorb energy when struck at one end would therefore be at High Water and from the above noted forces and deflections this would be:

$$\frac{181 \times 38.3}{2 \times 12} = 288 \text{ tons feet.}$$

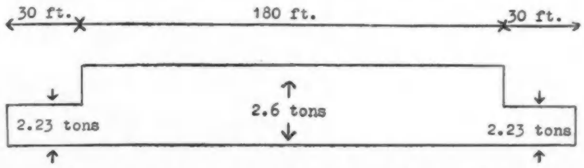
The maximum capacity of the beam would be when it was struck at the centre at Low Water so that it reached maximum deflection throughout its length. The total permissible deflection

Berthing Beam at Shell Petroleum Company's Rockfort Oil Installation, Jamaica.

A Berthing Beam for Large Vessels—continued

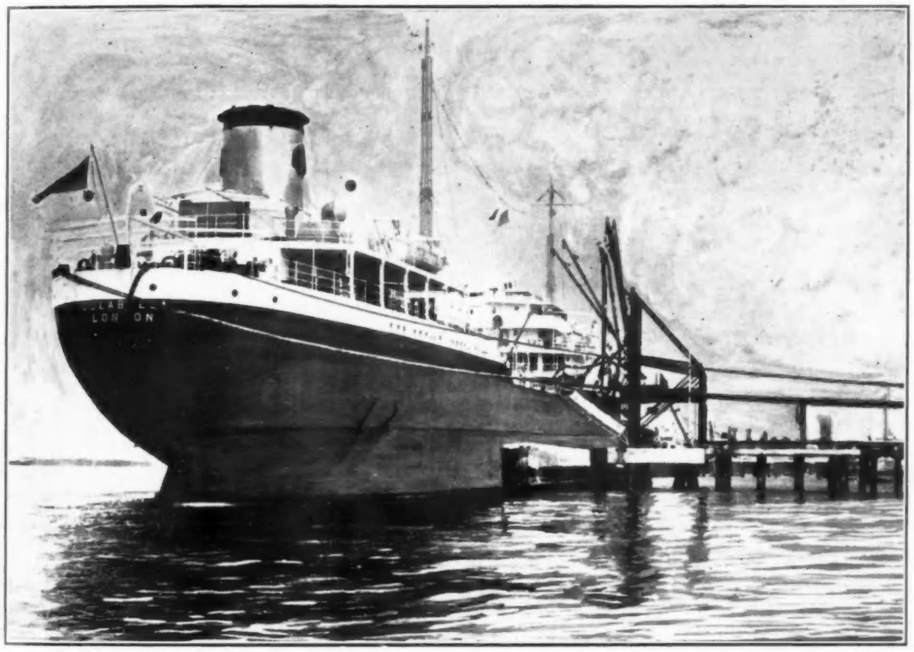
would be up to the point when the P.Sp.60s. piles became fully stressed i.e. 21.8-in. backwards from the point of zero stress or 21.8 + 7.5 = 29.3-in. measured from its forward "at rest" position.

The resistance diagram of the beams would then become:



From this the total load is 601.8 tons and the Kinetic Energy capable of being absorbed becomes therefore

$$\frac{601.8 \times 29.3}{2 \times 12} = 735 \text{ tons feet.}$$



M.T. *Dolabella* alongside one of the berthing beams at Pulo Bukom, Singapore.

The beam would of course also be responsive to forces acting parallel to its longitudinal axis.

It appeared therefore that the beam would have an energy absorbing capacity of between 288 and 735 tons feet depending on where the blow was struck and the state of the tide. This was of course substantially greater than any previously designed single fender unit and seemed to offer a very reasonable factor of safety particularly if it could be assumed that the structure would be called upon to absorb only 40 per cent. of the ship's energy. The table below gives the speed of approach of various sizes of ships which the beam could safely resist on that assumption.

Vessel	End blow	Centre blow
20,000 ton displacement	1.52 f.p.s.	2.28 f.p.s.
43,000 ton displacement	1.04 f.p.s.	1.57 f.p.s.
59,000 ton displacement	0.89 f.p.s.	1.34 f.p.s.

At least some of these approach speeds could be considered as being in the accident class and it was decided therefore to proceed on this basis.

The details of the design finally adopted for wharves 6, 8 and 9 are illustrated on the accompanying drawing.

Construction.

Work on the construction of three beams of this type together with ancillary civil engineering works in Singapore was completed in sixteen months at a cost of £281,000. These figures included all the civil engineering work in the beams, main and secondary jetty heads, mooring dolphins and 350-ft. of approach.

Apart from exceptionally hard pile driving conditions at Singapore no serious difficulties were encountered and the sections of the beams as they were concreted deflected forward more or less as anticipated, although some lining-up between adjacent sections had of necessity to be done before the joints could be concreted.

Pile Tests.

At both Singapore and Jamaica, horizontal loads were applied to selected piles to indicate whether the point of fixity assumed in the design bore any relation to fact. In Jamaica where the subsoils were silts and sands the depth of the point of fixity in the 10—18 tons per square inch range was shown to be about 11-ft. 6-in. In Singapore where the piles were driven to refusal in clay or shale having a sheer value in excess of 17.78 lbs./sq. inch, the calculated depth of the point of fixity from these tests reached 14-ft. 6-in.

As a result of these experiments the beam was moved backwards 6-in. in relation to the pile heads in order to reduce the pile stresses when the beam was in its "at rest" position.

Performance.

The Jamaica beam was the first to be completed, at a cost of £63,000 inclusive of berthing beam, secondary jetty head, mooring dolphins, buoys and tackle, etc.

Reports of its behaviour were awaited with interest but it soon became apparent that vessels were not striking it at velocities sufficiently high to produce deflections which would be of much use in checking the design assumptions. Arrangements were therefore made for a small vessel of approximately 9,750 tons displacement to berth under observation. Though the Master was asked to come alongside in quiet water at the highest speed commensurate with what he considered to be the safety of the vessel, the actual speed of approach normal to the beam was only 3-in. per second and the ship first touched the beam about 10-ft. from the West end. Deflections were reported to be 0.25-ft. at the centre and 0.19 and 0.31-ft. at East and West ends respectively. These and many other similar deflections reported from Jamaica seemed to indicate that the beam was not going to move as much in practice as the design calculations indicated it would do.

The completion of the Singapore beams followed and similar difficulties were experienced because of low approach speeds and small deflections. The highest recorded speed was 0.45 feet/second and the greatest recorded end deflection was 7-in.

The writer was however able to witness the berthing of a vessel of 25,000 tons displacement but unfortunately no prior arrangements had been made to record the deflections, speed and so on.

Whilst the ship was still some four or five yards away from the berth, the beam became "lively" and oscillated through a range of about $\frac{1}{2}$-in. in a direction normal to the face of the berth. This would appear to have been due to the alternate building up of a head of water between the vessel and the face of the beam and subsequent loss of head by escape under or around the ends of the beam.

The vessel approached at a speed which the berthing staff des-

A Berthing Beam for Large Vessels—continued

Shell Company M.T. *Dolabella:* 12,000 tons Deadweight, 16,800 tons Displacement, length 483-ft., alongside one of the berths at Pulo Bukom, Singapore. The berth will accommodate tankers of 59,000 tons displacement and 756-ft. long.

cribed as " very fast " and its bow quarter touched the beam at a point 10-ft. from one end. It is not thought however, that the speed exceeded 1-ft. per second. There was no blow as such when the ship touched the beam but ship and beam remained in contact as the beam retracted and until it returned to its position of rest, at which point the beam became stationary whilst the momentum of the vessel carried it a distance of two or three yards off from the berth. Meanwhile the ship had commenced to swing about its centre of gravity and its after part slowly came alongside the other end of the beam. Deflections observed at the centre of the beam were of the order of 4-in.—6-in. but no end deflections were recorded. These are thought to have been in excess of 1-ft.

The timber fenders at the point of impact were hardly compressed nor was there any mark on the vessel other than a slight rubbing of the paintwork.

One further point of interest was that the piles whilst deflecting normal to the face of the berth also deflected about half an inch in a direction parallel to it, demonstrating that energy was being absorbed in that direction also.

After the Singapore beams had been in service for some months a combination of circumstances led to one of them being very severely tested, but as is usual in such cases, no civil engineering observers were present at the time.

A vessel of almost 20,000 tons displacement was leaving a berth stern first when she was swung by the wind and current so that she became in danger of going aground on a reef which lies parallel to the berth. When at an angle of 45° to the berth and " bows-on " she started to go ahead and it was estimated that she struck the beam at a point 44-ft. from one end and virtually head on at a speed of 1 knot or about 1.7 feet/second. The beam retracted 1-ft. at the centre and " between 1- and 2-ft." at the end and returned to its normal position after the incident.

Both the speed of approach and the deflections are unfortunately without check but the observers were skilled berthing attendants and it is reasonable to assume that the estimate of speed was fairly reliable. That being so, the energy of the vessel would be almost 900 tons feet of which, due to the direction of approach it can be assumed some 800 tons feet had to be absorbed by the beam.

The damage sustained by the beam despite the knife edge blow was superficial and the berth remained in normal use whilst the tanker proceeded on her voyage undamaged.

It is interesting to note that the energy of the 20,000 ton tanker at the time of the incident was approximately three times that of a 59,000 tons vessel berthing under " normal circumstances " at about 7-in. per second.

The most important feature of this event however was that the beam appeared to be capable of absorbing much more energy than the original calculations had indicated and indeed the previously recorded small deflections also pointed in that direction.

From a general study of observed deflections it was evident that the beam was in fact bending very slightly in plan and a versed sine of up to 5-in. in 240-ft. has been recorded. This was contrary to one of the basic design assumptions and gives a very considerable additional safety factor. Associated with such resistance in bending will be the torsional resistance of the beam and a revision of the design is at present proceeding which it is hoped will evaluate these two factors and lead to further economies.

It should be recorded that no results of the bending of the beams can be seen on the site where the only cracks visible are hair cracks at construction joints which do not open, so far as can be seen, during berthing operations.

Conclusion.

It is felt that the berthing beam described fulfils a long felt want in so far as it can be built very rapidly at low cost without any special plant and caters with some margin of safety for the accident class of berthing incidents which are inevitable from time to time.

Acknowledgments.

The Civil Engineering Contractor for the work in Jamaica was Messrs. Marples, Ridgway & Partners Ltd., whilst Messrs. Gammon (Malaya) Ltd., built the berths in Singapore. The high tensile steel piling used in the Singapore berths was supplied by Messrs. Hüttenwerke Ilsede-Peine AG of Western Germany. The whole of the work was carried out for the Shell Petroleum Company Ltd., under the supervision of the consulting engineers Sir William Halcrow & Partners, MM.I.C.E., to both of whom the writer is indebted for permission to publish this article. He also wishes to record his thanks to those members of the Consultants' design staff who grappled with this awkward but interesting problem.

Improvements to Oil Docks at Port of Halifax.

The Imperial Oil Company is to spend nearly $2 millions on new docks and improved unloading facilities in Halifax harbour before the end of the year. The dock expansion programme, which will make it possible to berth the largest oil tankers afloat, is expected to be completed late in 1955. In conjunction with these improvements, two new storage tanks will be installed. Ships will discharge crude oil into a 24-in. line from any or all of the new and existing tankage.

Limited Prospects for English Canals

Report of the Board of Survey upon the Inland Waterways of the British Transport Commission*

THE report of the Board of Survey appointed by the British Transport Commission in April, 1954, has now been published. Ever since the end of the 1939-1945 War, the problems of the English canal system have been sufficiently serious to warrant a thorough investigation, but the paramount necessity has been for a decision upon the future of the various waterways, and for an agreed policy towards them. The decision announced by the Ministry of Transport and Civil Aviation last year to establish a Board of Survey was particularly welcome, if only because it was overdue.

It is important to recognise that the Board's terms of reference were as follows:—

"To survey the use at present being made of the Commission's inland waterways, and to report to the Chairman of the Commission:—

(a) whether all possible steps are being taken to ensure that the maximum economic advantage is being derived from the canal system under the Commission's control, and

(b) as to the steps to be taken in regard to such of the Commission's inland waterways as can no longer be put to economic commercial use."

Lord Rusholme was appointed as the representative of the Commission and the Minister approved the appointment of Sir Rex Hodges and Mr. R. D. Brown as independent members, forming a small Board of Survey under Lord Rusholme's chairmanship.

The Board have held several meetings in London and elsewhere and have visited the four waterways divisions and the canals in Scotland, where they have had an opportunity of seeing the condition of the waterways and obtaining first-hand knowledge of the problems involved.

A considerable volume of statistical and other information has been supplied by the Docks & Inland Waterways Board of Management and meetings have taken place with the Members of that body. The reports made to the Ministry of War Transport, including those of the late Mr. Frank Pick, have also been made available.

It must also be remembered that possible schemes for development of the English inland waterways system have been considered and presented by a number of eminent authorities. In some cases proposals had been based upon very full study of the civil engineering and economic aspects, and readers of the "Dock and Harbour Authority" will be reminded of the paper presented by Brig. General Sir H. Osborne Mance (see "Dock and Harbour Authority" (Jany., 1950), and of Mr. J. F. Pownall's plans for a grand contour canal, which would serve for water distribution as well as for transport. Both these proposals would require very substantial capital investment, and it has been thought that economic conditions have neither favoured nor demanded schemes requiring so much man-power and civil engineering plant and skill. Competing demands for similar resources, in order to improve roads and modernise railways and docks, have been powerful enough to result in any large scale proposals for canal modernisation being pigeon-holed.

On many occasions, in the "Dock and Harbour Authority," especially when the annual reports of the British Transport Commission have been reviewed, attention has been drawn both to the problems of the narrow gauge and other small capacity canals, which have been struggling to retain traffic under more or less uneconomic conditions and to the urgent need for a decision upon the future of the many miles of canals, owned by the Commission, upon which commercial traffic is negligible or non-existent. It has been repeatedly urged that, whilst the British Transport Commission is committed to maintain—at least to a standard to avoid public danger and often to comply approximately to statutory requirements—so many miles of canal with very little traffic potential, the Commission will have difficulty in directing vigorously its activities on the many miles which could carry more than they do at present. The Board has recognised these points and made proposals to deal with them; most of the proposals have been readily accepted by the Commission, but any plan to relieve the Commission of the uneconomic canals, including the Caledonian and Crinan small ship canals in Scotland, will require action by the Government.

Those who are concerned with this subject should study the report as published and will find the detailed statistics and analysis of income and expenditure upon individual canals most informative. However, the following summary, comments, extracts and conclusions will serve as some indication of the content of the report.

Historical Background

"The use of rivers for inland navigation is of great antiquity. The history of artificial waterways in this country—that is to say, of canals as distinct from canalised rivers—may be said to begin with the construction of the first Bridgewater Canal to carry coal from Worsley to Manchester, which was opened on July 17th, 1761. This proved so successful that the construction of other canals followed rapidly, and the period from 1760 to 1830 has been known as the 'canal era'. By the latter date, the year of the opening of the Liverpool & Manchester Railway, the whole of the canal system as it exists today, with the exception of the Manchester Ship Canal and a few minor branches, had been completed.

"With the advance of the railways the waterways lost the monopoly of inland goods traffic which they had previously enjoyed, and their position began to deteriorate. As railway competition developed, many were reduced to a precarious position. Efforts by Parliament to improve the competitive position of the canal companies by enabling them to vary their tolls, to become carriers of goods and to make working arrangements proved unsuccessful, and ultimately, in many cases at the instance of the canal companies themselves, about one-third of the total mileage then existing passed to the control of the railways. This occasioned much disquiet, and during the second half of the nineteenth century several public enquiries took place, but without any tangible result."

Mr. Charles Hadfield in his book "British Canals, an Illustrated History" recalls that in many cases the shareholders in canal companies which sold out to railways made good bargains for themselves, and it would be false to represent the railways as having driven the canals to bankruptcy or of their having in most cases cunningly acquired control of canal companies in order to stifle their trade. However, the canals that the railways acquired while they were consolidating their position became in most cases an embarrassment to them. The companies were by statute bound to maintain them in good order, and therefore many waterways were kept in more or less navigable condition up to the date of nationalization, which would have decayed if they had been in private hands. Such canals as the Grand Western and the Bridgwater and Taunton owe their present existence to railway ownership.

On the other hand, the railway companies naturally wished to carry traffic by rail and not by water, since otherwise they would have been maintaining a competition with themselves. Partly by intention, partly by neglect, the general effect of high tolls, lack of dredging, closings for leisurely repairs, decaying warehouses and wharves, failure to provide or maintain cranes, and no effort to get business, was to divert trade from the water to the land.

There were exceptions, either because the canals were indispensable for certain purposes, or because they served an area or attracted traffic not otherwise available to the railway company. The two most important were the Birmingham Canal Navigations and the Shropshire Union system.

Meanwhile, a number of Acts of Parliament, especially the Railway and Canal Traffic Acts of 1854 and 1888 and the Regulation of Railways Act of 1873, were passed to protect the canal system and the public wishing to use it. The 1873 Act required publication of rates and made the acquisition of a controlling interest by a railway in any further canals subject to official examination to protect the public interest, and furthermore required railways

*Published by the British Transport Commission, 1955, price 8s. 6d.

Limited Prospects for English Canals—continued

already controlling canals to maintain them " so that they may be at all times kept open and navigable for the use of all persons . . . without any unnecessary hindrance, interruption and delay."

Despite these checks, the share of the inland traffic borne by the canals was down to one eighth of the total by the end of the Century. Then came the 1906 Royal Commission, the recommendations of which included much enlargement on selected routes to pass either 100 ton or 300 ton barges, as compared with 50 tons in a pair of narrow boats. Had the advice of this Royal Commission been accepted the results would have been far reaching but, in the words of the latest report,

" Several members of the Commission dissented from the majority, being of the opinion either that the cost was likely to exceed the estimate, or that it was undesirable to attempt any improvement on such a large scale, or that canals had definitely been superseded by railways and that any expenditure on their improvement would be a waste of money.

" The weight of the dissentient voices and the criticism which was evoked in certain quarters, possibly assisted by a general lack of public interest in the subject, all helped to prevent any definite action being taken on the lines suggested by the Royal Commission."

Despite a further Royal Commission in 1930, little was done to remedy the gradual decay of traffic. There were however certain schemes of improvement. On the Grand Union Route extensive civil engineering work included increasing cross section, concrete bank protection and new locks between Napton and Birmingham; these permitted the passing of a pair of narrow boats at one locking and included such flights as the 21 locks at Hatton. These improvements allowed boats to move faster, although the new locks were found by the crews to be arduous in operation.

By 1953 the inland canals carried only about one per cent. of total inland tonnage, although the total of 12¾ million tons compares favourably with 11¼ million tons in 1949, and shows what has been done by the Commission, despite the very grave handicaps under which it has suffered.

Present Conditions of the Waterways.

The Report continues with a detailed review of the condition, to-day, of the various waterways, and draws attention to the fact that one third of the mileage " is no longer used by commercial traffic." An economic evaluation of the various canals is possible from the detailed appendices which show such wide variations as a nett surplus of £196,000 on receipts of £348,000 for the Aire and Calder Navigation, compared with a deficit of £40,000 on receipts of £6,500 on the Kennet and Avon Canal, which had suffered more than most from the effects of railway ownership and changes in the pattern of trade over a century.

Apart from investigations on site, the Board has listened to views from many bodies as the following quotations show:

" It is generally conceded that the principal routes have been materially improved since the Commission came into existence, and the **National Association of Inland Waterway Carriers,** to whose views we must attach weight, expressed appreciation of the steps which had been taken in consultation with them and felt that the Commission were proceeding on the right lines in quietly and efficiently endeavouring to see that the waterways which were most used were put right.

" On the other hand the **Inland Waterways Association** complained that the standard of maintenance on most of the waterways was not as it should be and they referred particularly to the condition of the Grand Union Canal between London and Birmingham."

" The **Severn Waterways Traders' Association,** whilst recognising the value of what had already been done by the Commission, suggested various measures for facilitating and improving navigation on that river, such as the raising of the level of water by the provision of flash-boards on weirs, alterations to certain locks and straightening and widening of bends. They also pressed for the completion of the steel piling at present being carried out on the Gloucester & Berkeley Canal, and the substitution by single-leaf steel bridges of the remaining double-leaf wooden swing-bridges, which necessitated the employment of an additional man to operate them. Other improvements proposed were of a long-term nature and included the construction of a second and larger lock at Gloucester, and the lengthening of the other locks above Gloucester.

" The Association also mentioned the navigational difficulties occasioned by the railway bridge immediately above Gloucester, which, although required by statute to be an opening bridge, was incapable of being used for that purpose."

" We discussed these comments with **Sir Reginald Hill,** the **Chairman of the Board of Management.** He said that the complaints made concerning the Grand Union Canal had been the subject of a detailed investigation and had not been substantiated, and that this route was being regularly used by the Commission's craft carrying full loads without difficulty, though he agreed that navigation required care owing to the restricted nature of the channel, which he would like to see progressively improved.

" Concerning the Severn waterway, Sir Reginald explained that a substantial programme for the piling of the Gloucester & Berkeley Canal would be completed this year. He agreed that Gloucester Lock was a bottleneck, and that in view of the increasing amount of traffic a larger lock was needed, and should be regarded as a matter of priority. The presence of bends in the section above Gloucester necessitated careful navigation, but with the improvements which had been effected by the Commission the condition was much better, though some further improvement was desirable. The main obstacle was cost."

The Board reaches the broad conclusion that on the main waterways very heavy expenditure is still required, and in no direction is the need more apparent than in that of remedying the effects of erosion. There is also the heavy cost of mining subsidence, amounting to a nett figure of £43,000 after allowing for sums recovered from the Coal Board and others.

On little used canals, the report makes the following observations:

" We have not alluded to those waterways which carry little or no traffic. Some of these have been formally closed or abandoned, but there are many hundred miles which the Commission are under a legal obligation to maintain in a navigable condition. Both the Commission and their predecessors have restricted expenditure to the bare minimum necessary in the interests of safety and to meet any legal requirements of water supply and land drainage. In many instances they present a picture of weed-grown channels and derelict locks. To rehabilitate them to normal traffic standards would involve a vast expenditure."

TRAFFIC ON THE WATERWAYS—CHARACTER AND DISTRIBUTION.

During 1953 the total traffic carried on the waterways was 12,747,000 tons, of which 6,930,000 was coal, 1,920,000 liquids in bulk and 3,897,000 miscellaneous (mainly general merchandise). There has been a gradual increase since 1949, as is shown by the following statistics:

	Coal Tons	Liquids Tons	Other Commodities Tons	Total Tons
1949 ...	5,566,000	1,745,000	4,015,000	11,326,000
1950 ...	5,791,000	1,835,000	4,176,000	11,802,000
1951 ...	5,844,000	2,036,000	4,356,000	12,236,000
1952 ...	6,322,000	2,021,000	4,099,000	12,442,000
1953 ...	6,930,000	1,920,000	3,897,000	12,747,000

The increase between 1949 and 1953 was not spread uniformly over the waterways as a whole, and there have been wide variations in particular cases. During this five-year period the following waterways gained traffic:

	1949 Tons (000's)	1953 Tons (000's)	Difference Tons (000's)	Percentage Increase
Aire & Calder	1,838	2,151	+ 313	17
Sheffield & South Yorkshire ...	811	914	+ 103	13
Trent	593	711	+ 118	20
Calder & Hebble	134	194	+ 60	45
Lee & Stort	1,814	2,048	+ 234	13
River Severn	347	462	+ 115	33
Gloucester & Berkeley	416	456	+ 40	10
Worcester & Birmingham ...	6	13	+ 7	116
Kennet & Avon (River Avon)	7	11	+ 4	57
Ouse Lower Improvement ...	1,181	2,308	+ 1,127	96
Total ...	7,147	9,268	+ 2,121	29

The following waterways have lost traffic:

	1949 Tons (000's)	1953 Tons (000's)	Difference Tons (000's)	Percentage Decrease
Dearne & Dove	54	—	− 54	100
Ripon and Ure	17	12	− 5	29
Others	33	17	− 16	48
Weaver	467	441	− 26	6
Leeds & Liverpool	838	803	− 35	4
Trent & Mersey	104	89	− 15	14
Shropshire Union	55	32	− 23	42
Others	49	27	− 22	45
Grand Union	916	788	− 128	14
Coventry	197	166	− 31	16
Ashby	7	2	− 5	71
Midland Narrow	1,166	946	− 220	19
Staffordshire & Worcestershire	60	8	− 52	87
Scottish Canals	103	94	− 9	9
Kensington	87	35	− 52	60
Total ...	4,179	3,479	− 700	17

It will be noted that the waterways on which traffic has increased are predominantly those which have connections with the ports. The North Eastern Division has benefited also from the increased conveyance of coal on the Aire & Calder, Sheffield & South Yorkshire and Calder & Hebble

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Navigations, and so has the Ouse Lower Improvement. The figures for the Trent and Severn Navigations and the Gloucester & Berkeley Canal reflect the growth of petroleum traffic.

Conclusions and Recommendations.

In view of the importance to be attached to the Board's conclusions and the fact that they so well summarise the whole position they are here reproduced almost in full:

PART I. As to whether all possible steps are being taken to ensure that the maximum economic advantage is being derived from the canal system under the Commission's control.

The waterways on the whole have been a declining industry since the advent of the railways over a hundred years ago, and the process has been accelerated with the development of road transport. In spite of recommendations by Royal Commissions and other bodies, little was done to remedy the situation until the passing of the Transport Act 1947, which placed the waterways under the control of the Commission, with certain exceptions such as the Thames Conservancy and the Bridgwater and Rochdale Canals. It is not surprising, therefore, that during the comparatively short period the waterways have been vested in the Commission a solution of the problems affecting these waterways has not been found. Faced with these problems the Docks & Inland Waterways Executive, and later the Board of Management, have accomplished much which should be of lasting value, and the main bodies of carriers all expressed their appreciation of what has been done. We found that many of the criticisms which had been made of the present administration were unjustified.

Nevertheless, the position of the waterways to-day cannot be regarded with complacency. While traffic on the estuarial and canalised rivers having connections with the ports has increased, that on most of the other waterways has declined. The main traffic routes, though in a better condition than they were before their transfer to the Commission, still require further and very heavy expenditure. Of the remainder many of the waterways are either disused or little used, and several, though not statutorily closed or abandoned, are no longer navigable and could not be made so except at heavy and unremunerative expenditure. Others which have been closed or abandoned are still maintainable by the Commission in order to meet such needs as water supply or land drainage.

Two-thirds of the system incur a heavy loss, and there is an overall deficit which has varied during the last three years from £573,367 to £102,060. No contribution to interest on capital or other central charges has been made. There are substantial losses on certain of the Commission's carrying services, and many private carriers, particularly on the narrow canals, have gone out of business and have not been replaced. There is in addition an acute shortage of labour in some branches of the carrying trade.

Before submitting our views as to the steps which should be taken to place the waterways on a sound basis, we will mention certain proposals which we regard as being outside our terms of reference. One proposal made was that traffic should be diverted from road and rail to the waterways. No method of compulsion exists by which this can be effected, since under the Transport Act, 1947, the trader has the freedom to choose such of the services provided by the Commission as he considers most suitable to his needs. The trader has also the right to provide his own road transport, and there is evidence of an increasing tendency for him to do so.

Another proposal made to us was that assistance should be given to the waterways, either in the form of a subsidy from central funds towards current expenses, or by way of payment towards the capital cost of the construction of works or provision of facilities. These issues are matters of public policy affecting the Commission generally and we do not propose to pursue them.

Nor do we feel that the proposal made by the Inland Waterways Association that the whole of the waterways should be transferred to a specially-constitued body would provide any solution if that body were required to undertake out of its own resources the maintenance and rehabilitation to a standard suitable for commercial navigation, where necessary, of the whole of the system as now existing. We regard their suggestions as unrealistic and impracticable.

We have also reviewed many schemes which have been put forward from time to time to enable estuarial craft to proceed beyond their present limits, or to widen narrow waterways to accommodate craft of standard dimensions which would be capable of navigating the estuaries. The works proposed would be equivalent to the construction of new canals and locks, reservoirs, etc., and the cost, including the provision of craft and terminal facilities, would be of such a magnitude that they could not pay their way unless they were heavily subsidised by the State.

In arriving at this conclusion we are supported by the views of the Royal Commission of 1906, the Departmental Committee on Inland Waterways, 1920, and the Royal Commission on Transport, 1930. For the purposes of our Report we have not therefore taken into account the possibility of financial assistance or of compulsory direction of traffic.

We are asked to consider whether all possible steps are being taken to ensure that the maximum economic advantage is being derived from the canal system under the Commission's control. It would be strange indeed if we were able to say that we are convinced that all possible steps had been taken, for this would indicate a state of perfection which it is not in human beings to attain. We have, however, evidence to show that those responsible for the Commission's canals and inland waterways have in a variety of ways improved their efficiency and finances. On the financial side alone this is indicated by the reduction of the deficit to £102,060 in 1953. This result has been achieved by increasing revenue from tolls and water-rents, and by reduction in expenditure.

On the efficiency of the canal system, within the limits of finance available a great deal has been done by improved dredging, piling of banks, improvement of towpaths, etc. To this fact tribute has been paid by the representatives of canal users.

One point made to us has been the fear that in the hands of a body which has a responsibility for docks as well as inland waterways there may be a tendency for a greater attention and expenditure of finance for maintenance and improvements to be directed to the section, i.e., the docks, which represents the larger-earning section of the organisation. While there is no evidence that such is in fact the case, we have come to the conclusion that the canal system under the control of the Commission is a separate and distinct business and is sufficiently large and important to warrant separate management.

We accordingly recommend the establishment within the Commission of a separate organisation to deal with the waterways, under the control of a General Manager who would be able to give them his undivided attention. We also recommend that the waterways for this purpose should be regarded as including the Docks at Sharpness and Gloucester (with the Gloucester & Berkeley Canal), Goole (with the Ouse Lower Improvement) and Weston Point and the Regent's Canal Dock, which were formerly part of waterway undertakings.

The next steps, in our view—and to these we attach the greatest importance—must be to concentrate on those activities which are of real value as part of the transport system, and to relieve the Commission of the remainder, which are placing a heavy burden upon the waterways administration and finances.

We agree with the statement published by the Commission in 1950 that inland water transport is specially suitable and efficient for—

- (a) traffic imported and for shipment in the ports connected with the inland waterway system, particularly in those instances where overside delivery from ship to barge or vice versa takes place;
- (b) traffic which can be carried from point to point in barge-loads;
- (c) traffic conveyed to or from waterside premises;
- (d) petroleum and liquids in bulk;
- (e) traffic requiring bulk movement and storage in the canal-side warehouses;
- (f) trunk haul to river or canal waterheads with subsequent delivery by road.

This indicates the field in which the maximum effort should be applied, and we add the following comments. Where goods can be loaded or discharged overside either without port dues or with a substantial reduction, water transport has a considerable advantage, but this may to some extent be reduced or lost where, owing to physical limitations, it is necessary to tranship goods at intermediate points into or out of smaller craft. Equally, liquids in

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bulk can be conveyed in large tank craft to inland depots situated on the waterside, from which they can be distributed by road.

Another field in which waterways may be said to be competitive is the transport of coal in large quantities. This applies particularly to the compartment-boat system operating in the North Eastern Division for the conveyance of coal to Goole, where it is tipped into seagoing ships by means of special appliances. The provision of such a system is exceedingly costly and requires heavy and regular movement of traffic and a relatively straight waterway with a minimum of locks. These conditions exist only in rare cases.

The waterways are extensively used for the conveyance of coal to electric power stations, gasworks and industrial installations. Relativity of cost has been affected by the application of a service charge by the National Coal Board which, though justified from their standpoint, has worsened the competitive position of the waterways. This has to some extent been improved by toll reductions. The view of the British Electricity Authority is that the margin between canal and rail or road charges on the narrow and heavily-locked canals in the Midlands, with the restricted payload of the craft, is insufficient to induce the Authority to provide facilities at new power stations for the intake of coal by canal as well as by rail or road. They consider that in Lancashire, where larger craft are employed, conditions are generally more favourable, and that in Yorkshire, with barges carrying from 70 to 240 tons, charges are highly competitive.

Well-equipped warehouses provide an inducement for traders to use the waterways. Under Government bulk purchasing, warehouse space was extensively used, but with the freeing of commodities from control there is a tendency for them to pass in smaller consignments which cannot always be economically conveyed by waterway. This has also reduced the demand for warehouse accommodation.

Competition by other forms of transport is severe, and as far as general merchandise is concerned is likely to become more so with the freeing of road transport and the growth in the number of 'C' licences. Narrow canals which are capable of carrying approximately 50 tons per pair of boats are specially vulnerable to this kind of competition, particularly where the locks are of insufficient size to accommodate a pair of boats in one operation. The Grand Union route between London and Birmingham does not suffer from this disability.

Above all, there is the need for overcoming acute difficulties in manning craft, which were frequently emphasized in the course of our investigation.

After careful consideration we have placed the waterways in three categories, according to their economic prospects; waterways to be developed, waterways to be retained, and waterways having insufficient commercial prospects to justify their retention for navigation.

GROUP I. WATERWAYS TO BE DEVELOPED. TOTAL MILEAGE 336.

Aire & Calder Navigation (including Ouse Lower Improvement)
Gloucester & Berkeley Canal and the River Severn
Grand Union Canal (Regent's Canal Dock and Brentford-Berkhamsted)
Sheffield & South Yorkshire Navigation
River Lee (below Enfield Lock)
River Trent
River Weaver

These waterways carry substantial traffic and offer scope for commercial development. They should be improved by the elimination, where necessary, of accumulated arrears of maintenance, by dredging, bank protection and other improvements, and by provision of suitable handling and terminal facilities. It must, however, be appreciated that such work will involve heavy expenditure, but in our view, where economic justification exists, such expenditure should be undertaken.

GROUP II. WATERWAYS TO BE RETAINED. TOTAL MILEAGE 994.

Ashby Canal (used section)
Birmingham Canal Navigations
Calder & Hebble Navigation
Coventry Canal
Fossdyke Canal
Grand Union Canal (above Berkhamsted)
Kennet & Avon Canal (River Avon section)
Kensington Canal
Leeds & Liverpool Canal
Oxford Canal (northern section)
River Lee (above Enfield Lock) and River Stort
St. Helens Canal
Shropshire Union Canal (Main Line)
Staffordshire & Worcestershire Canal (but see below)
Stourbridge & Stourbridge Extension Canals
Stratford-on-Avon Canal (northern section)
Trent & Mersey Canal
Worcester & Birmingham Canal (but see below)
Ure Navigation

The waterways in this group appear, under existing conditions, to be worth retaining for transport purposes, either by reason of the tonnage of traffic upon them or because they form part of a through route. They should be maintained for the present to an adequate standard of efficiency. Every encouragement should be given to the development of traffic. If, however, it becomes apparent in the light of further experience and after consultation with the appropriate Transport Users' Consultative Committee that the retention for transport purposes of any of these waterways is no longer justified, they should be transferred to the next category. in the pattern of trade over a century.

The National Association of Inland Waterway Carriers agree that there is no need to retain for transport purposes both the Worcester & Birmingham Canal and the southern section of the Staffordshire & Worcestershire Canal, which form alternative routes from the Severn to the Midlands system. We recommend that the Commission should carefully consider the facilities which these canals provide and the traffics at present carried with the object of determining which of these two canals should be retained as the connection between the Severn and the Midlands system.

GROUP III. WATERWAYS HAVING INSUFFICIENT COMMERCIAL PROSPECTS TO JUSTIFY THEIR RETENTION FOR NAVIGATION. TOTAL MILEAGE 771.

*Ashby Canal (upper part)
Ashton, Peak Forest and Macclesfield Canals
*Barnsley Canal
Bridgwater & Taunton Canal and River Tone Navigation
Chesterfield Canal
*Cromford Canal
Dearne & Dove Canal
Erewash Canal
Forth & Clyde Canal (including *Monkland Canal)
Grand Western Canal
*Grantham Canal
*Huddersfield (Narrow) Canal
Kennet & Avon Canal (Reading to Bath)
Lancaster Canal
Manchester, Bolton & Bury Canal
Monmouthshire & Brecon Canal
*Nottingham Canal
Oxford Canal (southern section)
Pocklington Canal
Ripon Canal
*Shropshire Union Canal (Welsh section)
*Shropshire Union Canal (Montgomery and Shrewsbury sections)
Stratford-on-Avon Canal (southern section)
Swansea Canal
Union Canal (Scotland)
Witham Navigation

These waterways are either disused or carry insufficient traffic to justify their retention as commercial navigations. Those marked with an asterisk have already been formally closed to traffic or abandoned, and there are parts of others which have been similarly dealt with. There are also certain arms and branches of canals in the other categories, such as the Rufford branch of the Leeds & Liverpool Canal and the Aylesbury arm of the Grand Union, which serve little or no useful transport purpose, and should be placed in this category. The waterways in Group III involve a dead loss of about £200,000 per annum.

The Caledonian Canal was built and operated by the State, and the Crinan, although originally constructed by private enterprise, was supported by Treasury contributions until 1848 when it also passed to State control. Prior to the transfer to the British Transport Commission in 1948 the two canals were administered by the Ministry of Transport. They have a small but seriously inadequate commercial traffic and have for many years been worked at a heavy loss (£43,049 in 1953). We have considered the representations made to us on behalf of the Scottish Council (Development & Industry) and the Scottish Board for Industry, who emphasized

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the importance of these waterways to the economic life of Scotland. In the circumstances we are of opinion that they should be transferred to the Secretary of State for Scotland, together with the Forth & Clyde, Monkland and Union Canals, which three canals in our view are of no real value for navigation, but may be needed for purposes such as water supply.

PART II. As to the steps to be taken in regard to such of the Commission's inland waterways as can no longer be put to economic commercial use.

We have now indicated those waterways which in our view are no longer of economic value, and we are required to report as to the steps to be taken with regard to them.

We received representations from the Federation of British Industries, the British Electricity Authority, the National Farmers' Union and others emphasizing the importance of retaining such waterways for the purposes of water supply, land drainage and the disposal of effluents. Other possible uses are for pleasure boating and fishing, and several waterways constitute valuable amenities. The existence of these ancillary uses has in the past proved an obstacle to physical abandonment, and, as we have explained, many hundred miles of waterways are now being maintained by the Commission at heavy cost for purposes wholly unconnected with transport.

The future of these waterways was considered some years ago by the Land Drainage Legislation Sub-Committee of the Central Advisory Water Committee. In their Report, published in 1951, they state that River Boards are best fitted, from the point of view of both functions and constitution, to deal with the problem. They make several recommendations with a view to facilitating transfer to such boards. The Minister of Transport, in conjunction with other Government Departments, has invited the views of a number of bodies (including the British Transport Commission) on questions arising from the recommendations contained in the Report, and we feel that it would be inappropriate and unnecessary for us to conduct an inquiry into matters which are already the subject of an investigation by the Government. We would, however, support the views expressed by the British Transport Commission that the time has now arrived for requiring these waterways to be transferred to the authorities most appropriate in each case, subject to any necessary financial adjustments on an equitable basis and taking into account any benefit to be derived by the transferee authorities from the transfer, and that all financial responsibility for adapting the waterway to other purposes after transfer should be placed upon the transferee authority. It is important that an early decision should be reached by the Government on these matters.

A suggestion made to us was that the sites of abandoned canals should be utilised for the construction of roads. Apart from the question of disposing of the water, the land available is often of insufficient width to accommodate a modern road, and in heavily built-up areas this would involve the demolition of buildings at great expense. Overbridges and tunnels would usually require alteration owing to their limited capacity. Many cnaals do not run in a direct line but follow the contours of the land in a manner which would scarcely be suitable for a road. The physical conditions vary within wide limits, and only by a close investigation of each case could the practicability of such proposals be determined in the light of the expenditure involved.

We should have preferred that, pending the abandonment or transfer to other bodies of the uneconomic waterways, the General Manager and the Divisional Waterways Officers should not undertake the responsibility for their administration, and should be free to devote all their time and energies to the management of those of commercial value. There are, however, difficulties in effecting a separation at this stage, and we recommend that the establishment at Headquarters and in the Divisions should include staff capable of relieving the management, as far as practicable, of this branch of the work.

We firmly believe that the measures which we have proposed, while not in themselves providing a final solution, will enable the canals and inland waterways under the control of the British Transport Commission to be used to greater advantage and to play a more active part in the transport system. There is, not unnaturally, great uncertainty and doubt as to the future in the minds of those engaged in the industry. This should be dispelled at the earliest possible moment, and we must therefore emphasize the need for urgent action in the directions we have indicated.

Future Action

There only remains the matter of implementing the recommendations of the Report. The Chairman of the British Transport Commission, Sir Brian Robertson, in the Foreword to the Report, accepts and indeed strongly endorses these recommendations, several of which have already been adopted. The crux of the matter is, however, that the Commission should no longer be saddled with the continuing financial liabilities for the Waterways in Group III listed above, and for the Scottish ship canals, and on this very difficult question, the Commission undertakes to make further representations to the Government. Most of these canals are of considerable historic interest and of peculiar beauty; it would be deplorable if a continuing policy of inactivity and indecision persisted. The realistic proposal to transfer these to River Boards at an early date will satisfy all those interested in commercial inland water transport; it might also achieve the admirable object of retaining these as pleasances and for useful purposes other than commercial transport; furthermore it would satisfactorily dispose of the engineering problems which would arise in any scheme for filling in these canals, and of the vociferant outcry which the latter would arouse.

G. L. H. B.

British Industries Fair, 1955

Exhibits of interest to Port Authorities and to Civil and Mechanical Engineering Contractors at the Birmingham Section of this year's British Industries Fair embraced conveyors, slings, fork-lift trucks, marine lighting, plant for mechanical handling, contractor's plant, railway track equipment and road-making equipment. The organisers of the Fair are anxious to attract overseas buyers, and with export traffic in view, the British Transport Commissioners, Newport (Mon.) Corporation, Plymouth Corporation, and the Port of London Authority has established information offices on their stands. As a shop-window the Birmingham Section of the Fair surpassed itself this year, the standard of display having improved each year since the Fair was resumed after the war. The Port of London Authority's stand, designed by John Lansdell, F.R.S.A., was among the best of the 1,000 at this section of the Fair.

The biggest individual exhibit was a composite Bailey bridge more than 200-ft. long. It was of necessity, in the outdoor section and incorporated developments shown for the first time. Among fork-lift trucks exhibited was one which is claimed to be the smallest in the world, its overall depth being only 7½-in. A battery electric fork-lift truck shown is stated by its makers to be the smallest rider operated electric fork-lift truck in Britain, the 1955 model incorporating many novel features which make it practically fool-proof in operation.

A Freightlifter industrial fork-lift truck exhibited for the first time, is designed to handle loads in confined spaces, its turning radius being only 9-ft. 8-in.

The main feature of a new crane exhibited is that it is easily convertible from a pneumatic tyred vehicle to a tracked vehicle without a major workshop operation. The manufacturers believe that it is the only small crane with such a wide range of equipment.

A new plastic speed boat exhibited is the latest development from improved plastic technology and new construction technique. The most important factor in the process is the use of a thixotropic filler, which when added to polyester resin enables it to be worked successfully on vertical surfaces.

Terylene and nylon ropes, cords and canvases were among the many examples of the use of synthetics in rope-making. In recent trials on the Thames it was found that the life of a 6-in. circumference Terylene rope was 137 days compared with six days for a sisal rope of similar size. The makers claim that Terylene ropes remain flexible when wet and that the lightermen find them much easier to work with.

The Humber Ports

(8) Future Developments

(Specially Contributed)

(Continued from page 372)

Previous articles in this series have included reference to works in progress at the Humber Ports, and in this concluding article it is proposed first to review one or two matters of general importance in the operation of the ports and then briefly to survey probable lines of future development.

Dredging.

The River Humber is only 40 miles long, but it drains about 25% of the land surface of England and has been estimated to contain not less than 12 million tons of material in suspension at any time. The natural course of the river, although subject to considerable variation and demanding frequent alterations in the positions of marking buoys, provides a more or less clearly defined channel of sufficient width and depth for navigation purposes. Siltation in the approaches to Hull, Grimsby and Immingham and in the docks themselves is, however, heavy and constant dredging of the order of 8 million tons per annum is necessary to maintain adequate depths for shipping using these ports. This dredging is carried out by the British Transport Commission's Humber Ports organisation with a fleet of some 40 vessels based on Hull but used in common for the three ports.

The nature of the dredging work demands the use of various types of craft. Five bucket dredgers, the largest of which has an average output of 845 tons per hour, are regularly employed in the docks and their approaches. Each bucket dredger has a complement of attendant craft, self propelled hopper barges, tugs and dumb hoppers, according to the requirements of the situation in which it is working. The material is carried by these attendant craft and deposited in the River Humber by agreement with the Humber Conservancy Board at certain specified times relative to high water. Three suction hopper dredgers are also continually employed in the entrances and approaches, and five grab hopper dredgers are used additionally within the docks. These vessels carry their own spoil to the deposit grounds mentioned. About 50% of the total output is dealt with by the suction dredgers, while the bucket dredgers and grab dredgers are responsible for about 40% and 10% respectively.

When the British Transport Commission took over the docks, many of the vessels were over 40 years old, and a large-scale replacement programme has therefore to be faced.

A start on such a programme was made by the placing of an order for a diesel driven single screw twin grab hopper dredger in January, 1952, the vessel having a length of 156-ft. B.P., moulded breadth 34-ft., and a hopper capacity of 750 cu. yds. The vessel was built by Messrs. Cook, Welton & Gemmell, Ltd., at Beverley, on the River Hull, the engines were supplied by Messrs. Ruston & Hornsby, Ltd., and the grabbing cranes by Messrs. Priestman Bros. She was delivered to Hull in October, 1954, and is proving an efficient and economical craft for her particular purpose.

In the meantime a further contract had been let to Messrs. Cook, Welton & Gemmell, Ltd., for four dump hopper barges, two of 550 cu. yds. and two of 750 cu. yds. capacity, and these were successively completed and put into service between December, 1953, and April, 1954. This was followed by the placing of an order with Messrs. Richard Dunston, Ltd., for construction at Hessle on the Humber of a single screw diesel propelled hopper barge of 1,000 cu. yds. capacity with a length B.P. of 186-ft. and a moulded breadth of 37-ft. 6-in., equipped with power operated bottom doors, and a further contract has since been let to the same firm for construction at Thorne of a single screw diesel tug of dimensions 70-ft. by 18-ft. 6-in. and about 420 B.H.P. All these vessels have been or are being constructed under the special survey of Lloyds Register for the particular type of vessel, and the requirements of the Ministry of Transport are being fully implemented in the design, construction and equipment.

As a temporary measure pending the further development of the replacement programme, the dredging fleet has been augmented by the purchase second-hand of a T.I.D. tug of length 65-ft. B.P. and moulded breadth 17-ft., powered by a compound steam engine developing 220 I.H.P., and a steam hopper barge of dimensions 173-ft. by 32-ft., with a hopper capacity of about 640 cu. yds. Proposals are under consideration at present for a new diesel-powered suction dredger with a dredging depth of 50-ft. and hopper capacity of 1,500 cu. yds.

The above remarks apply to the fleet as operating at Hull, Grimsby and Immingham. Dredging at Goole is carried out by a separate dredging unit which at present consists of a small capacity ladder bucket dredger with four mud boats and a canal type tug, from which dredged material is deposited either over the canal banks or on a deposit ground in the River Ouse. An order is now being placed for a diesel propelled single screw grab hopper dredger of 112-ft. B.P. and 28-ft. moulded breadth, with a hopper capacity of 300 cu. yds. and power operated bottom doors, which, when it is delivered, will meet the needs of Goole and enable all the existing old craft to be dispensed with.

Sounding.

Dredging problems at the Humber Ports are such that a regular programme of marine soundings is essential. In 1952 echo sounding was introduced, a Kelvin and Hughes Type M.S. 21A machine being obtained and installed in the Hull sounding launch. This was followed in 1953 by the purchase of a similar machine, Type M.S. 26A, for the Goole sounding launch. Experience has shown that while echo sounding is very satisfactory in the case of Goole and the channels of the River Lower Ouse, the comparative results of sounding by the echometer and by lead line at Hull, where the waters of the Humber contain very considerable amounts of silt in suspension, have shown various discrepancies to which a final solution has not yet been found. To a large extent it has been necessary to revert to lead line soundings in order to get a true picture of the need for dredging in various parts of the docks and their approaches, but the echometer is nevertheless considerably used for various purposes.

Twin Grab Diesel Hopper Dredger "Burcom Sand."

The Humber Ports—continued

Mechanisation.

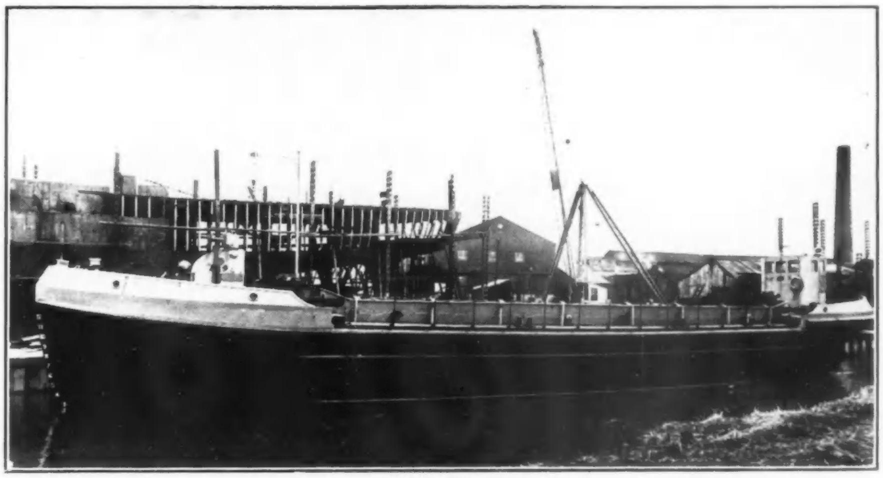
In the engineering department a great deal of work was up to 1948 done by horse and cart, and when the British Transport Commission took over a programme of replacement by mechanical equipment was undertaken and has now been completed. There was also a need for special equipment to reduce the amount of hand labour on various works in progress, and this has been met by the purchase of petrol driven dumpers of varying capacities and types. Whilst large items of earth moving and excavating plant are usually hired as required, a Weatherill diesel driven hydraulic loading shovel with a scoop capacity of up to one cu. yd. has been obtained for Hull and is proving a valuable general utility tool. At Immingham a Whitlock "Dinkum" hydraulic digger attached to a Fordson Major diesel tractor has recently been purchased and is doing valuable work on the excavation of trenches for the replacement of hydraulic mains. The need for up-to-date equipment for consolidation of the ground in engineering works and for road repairs has also been met by the purchase of an Aveling Barford type G.D. diesel driven 10-ton road roller and a Green's type 2½-ton diesel road roller for use at Hull, and an 8-ton diesel road roller by the latter firm for use at Grimsby. Thirteen new concrete mixers have been obtained in recent years and fifteen air compressors, special attention being given to expediting site work by better provision of pneumatic tools, and further developments in this connection are under consideration.

Modern techniques in bulk handling of cement have not been overlooked, and a portable cement silo served by the pressurised tanker fleet of a local firm of cement manufacturers has been obtained and is giving satisfactory service. A vibrating table has also been obtained for the effective compacting of pre-cast concrete units in connection with up-to-date methods of building construction.

A very considerable mileage of dock sidings has to be maintained by the engineering staff and new methods are being introduced so that the work may be carried out with the fullest economy and efficiency. A recent development in this connection has been the adoption of Thermit welding of rails to eliminate maintenance attention to rail joints and to ensure smoother running of vehicles.

Chemical weed-killing has been adopted to all the Humber Ports and petrol-driven rail trollies and trailers with spraying equipment have been specially obtained for the purpose.

Lifting appliances of a portable or mobile nature are essential for various purposes in a dock and harbour undertaking. The older steam cranes have been replaced principally by diesel road mobile cranes, although some diesel rail travelling cranes were necessary for particular purposes. A total of nearly twenty new mobile cranes, rail or road, has been acquired or ordered either for engineering or traffic purposes. Portable lifting plant



Dumb Hopper Barge No. 35 under construction at Beverley, capacity 550 cu. yds.

for engineering work has also been augmented by the provision of a number of 1-ton or 2-ton light derricks, and a 65-ft. steel piling frame has been obtained in replacement of a number of old wooden frames.

Engineering Re-organisation.

The Commission's policy is to concentrate the supervision of their engineering works in one department, and a Chief Docks Engineer responsible for all engineering work was appointed in January, 1955. Improvements have been made in various directions to ensure more adequate supervision of the direct labour force, which amounts to 2,500 men at the Humber Ports as a whole, and at Hull a re-organisation of the outdoor supervisory arrangements has been put into effect on a geographical, as opposed to the previous trade, basis.

The Future.

Planning for the future is particularly difficult in the sphere of port developments where installations have a very long life and must cater for changes in ship design. As far as can be seen at the moment, the next scheme of reconstruction at the Humber Ports is likely to be that of the Riverside Quay and the complementary development of the south side of Albert Dock. During 1941 the timber built Riverside Quay, which had handled the near-Continental perishable traffic since 1907, was destroyed by enemy action and, subject to the successful outcome of discussions with the Hull Corporation and the Chamber of Commerce, the Commission now propose to rebuild these quays in concrete and to provide sheds for the fruit and vegetables and other perishables discharged in the river and for general cargo which is dealt with on the south side of Albert Dock. The Riverside Quay itself will be 1,000-ft. long, carrying three sheds each 300 x 85-ft. and equipped with three 6-ton and six 3-ton electric cranes. The quay on the Albert Dock side of the installation will carry four sheds each 290-ft. x 85-ft. and will be equipped with one 10-ton and eight 3/6-ton electric cranes. The plans include road works, wagon and crane tracks, passenger and customs accommodation, sundry buildings, electric, water and hydraulic mains, and the total estimated cost is £1,500,000.

Since the war there has been an increased demand for shed accommodation at each of the Humber Ports and whilst at Hull this will be partly met by the Riverside Quay reconstruction, a scheme is under discussion for the provision of two large sheds, 450 x 150-ft., on the rebuilt No. 12 Quay at King George Dock.

During the autumn of last year hand scuttling of grain ceased and mechanical means are now wholly employed. Elevator equipment is provided at three silo berths in the King George Dock, Hull, and at one of these the present apparatus is to be replaced by four land based suction elevators, two of which are expected to be in service by next year and the others shortly after. The new suction elevators will be mounted on wheels at 15-ft. centres running on the existing crane track, which will be extended about 70-ft. in a westerly direction. The machines will have a capacity of 120 tons an hour and will be fitted with booms 60-ft. in height from the quay, each with a radius of 40-ft., and the intake will be through nozzles of 7-in. diameter. The total cost of the installation will be of the order of £250,000.

The firms already established on the Salt End estate are expanding and this factor, coupled with the increased use of oil, is already placing a heavy demand on the berthage available at the two Salt End jetties. One of these is due for reconstruction in the comparatively near future and the Commission are to consider the provision of a third jetty initially, so that thereafter the old jetty can be reconstructed without a temporary reduction in the total facilities available. When the reconstruction work is complete the berthage available at the three jetties will continue in use, resulting in a

The Humber Ports—*continued*

New Wool Shed at Branch Dock, Goole, March, 1955.

50% increase of the oil berth facilities at Hull.

The programme of road improvements mentioned in earlier articles is proceeding and far-reaching plans for the future have been made. These include proposals to continue the widening of the north roadway at King George Dock, part of which was undertaken in 1951 to extend past the coal conveyor berths under the gantries feeding the coal hoists and along the northside of No. 2 Graving Dock and thence to Nos. 12 and 8 Quays. The width of the new road would be 30-ft. between kerbs, except where dual carriageways of 16-ft. each are contemplated over a length of approximately 120-ft. At Alexandra Dock the reconstruction of the ring road will proceed initially along part of the section on the north side of the dock and later in the jetties area in the south-east corner.

Improvements in the rail layout for dealing with timber imports are also under consideration, these having become necessary because a considerable volume of additional traffic and longer hauls to the timber grounds have caused some congestion in rail movement. Additional timber storage grounds are also being provided at Victoria Dock.

Throughout the Hull docks, improvements to the dry docks are being progressively undertaken which, whilst not of a major character, will bring these facilities up to modern standards.

On the south side of the river the growth of the oil business at Immingham, now dealt with over the Eastern Jetty, has necessitated the laying of an anchorage so that an additional berth may be made available, and the whole of the land between the jetty and the eastern boundary of the dock estate is now leased to the Oil Companies for the storage of oil. The renewal of three coaling appliances on the south side of the dock has already been mentioned and proposals are now being developed for the modernisation of the crane power of the remaining portion of the Mineral Quay and at the principal cargo berths.

At Goole the capacity of the West Dock, opened in 1912, is to be increased by the provision of higher capacity cranes and by the construction of a new berth on the south side of the dock.

Further development at the Humber Ports is dependent upon conditions of trade, and while up to the present a good deal has been done in the way of rehabilitation and in overcoming war arrears of maintenance, in the future emphasis will be placed on works to provide for expanding trade, for the prospects are good and the future of the ports can be faced with confidence.

Centenary of Aluminium

Progress Exhibition in London

The aluminium industry is to present a progress exhibition at the Royal Festival Hall, London, from June 1—10. This will mark the centenary of aluminium as a commercial metal and will also give a convincing demonstration of how the present vast output and unique experience already gained are now being applied to industry in increasing measure.

Aluminium was first exhibited at the Paris Exposition in 1855 by the French scientist, Professor St. Claire Deville, who had succeeded in extracting the new metal from clay by a chemical process. The aluminium thus obtained was rated a precious metal, since it cost £60 per lb. to produce. In 1886, two scientists, Charles Martin Hall, in America, and Paul Heroult, in France, working independently simultaneously patented the electrolytic process for extracting aluminium from its oxide. To-day, using basically that same method of extraction, 30,000 tons of pure aluminium are produced in Britain alone, and world production in 1954 has probably exceeded 3 mn. tons and is still increasing.

In 1907 came the discovery, by a German scientist, Alfred Wilm, that by alloying small quantities of other metals with aluminium its strength could be greatly increased. Further research and development in this country produced a wide range of alloys which made possible the development of the aircraft industry and of the internal combustion engine.

The 10 years that have elapsed since the Second World War have been years of rapid progress when research results have been applied to problems in every industry. First came the aluminium prefabricated house, 70,000 of which were built, to be followed by the adoption of aluminium in permanent building construction. In shipbuilding its success was strikingly demonstrated by the American liner United States, which has over 2,000 tons of aluminium in her superstructure, lifeboats, and many fitments. Less spectacular applications of aluminium to ships had already become a commonplace in Britain. The world's first aluminium bridges have been built in Britain, and aluminium coaches and bus bodies provide evidence of the faith of the engineer in aluminium.

The Exhibition.

The exhibition is primarily directed to all present and potential users of aluminium. In particular it will interest professional engineers, designers and architects, representatives of the Government, local authorities and the great industries of Britain. It is expected to attract Commonwealth and foreign visitors, and also teachers engaged in university and higher technological education.

The exhibition is divided into five main sections. The first sets out to depict the history of the metal and will show the transition from the chemical to the electrolytic process, from 1886 to the present day, including the discovery of the principal alloys and their commercial adoption.

The second section has research as its theme and will show how the aluminium industry has been built on research, and will illustrate, accurately but in simplified form, the sound scientific basis of the industry.

The section on production will demonstrate, by diagrams and models, how aluminium is extracted and fabricated into semi-finished forms, together with the products resulting from each process. A statistical section will show the location of the ore (bauxite), world production and the output in the United Kingdom.

The largest section of the exhibition deals with the present-day uses of aluminium. It will cover all fields of application and will be illustrated, not only by photographs, drawings and models, but whenever possible, by actual full-scale examples of road and rail vehicles, boats, chemical and electrical plant, etc.

In the section on the future of aluminium, technical discussions will be held. These will summarise progress and future possibilities in the use of aluminium.

The Application of Cellular Piling

Its Uses for Temporary or Permanent Works*

By G. BOUZIGE.

ONE solution to the problem of retaining water and soil, dating from the first lake cities of antiquity, is to employ timber. At first untrimmed logs were used, but later squared timbers were employed, more or less reinforced by horizontal or vertical members after the manner of shuttering.

In order to achieve watertightness, more particularly in the case of cofferdams, it is common practice to drive two parallel lines of sheet piling, firmly connected together by transverse bulkheads, the cells thus created being filled with impermeable clay, generally puddled (Fig. 1). The employment of timber continued towards the end of the nineteenth century, when steel replaced timber in shipbuilding and the first steel sheet piling appeared in the form of the Universal section. Later, many sections were developed, based on an undulated pattern in order to increase resistance to bending.

Undulated pile sections are employed in the structure shown in Fig. 2, where the soil is retained by the sheet piling ABC, of which the length BC provides the necessary resistance to the earth pressure, which tends to bend the portion AB. This resistance is inadequate when the height AB reaches a certain value, and the top of the piling is then held back by tie rods DG fixed to the sheet piling and terminating at the rear in the anchorage EF (which may be either a reinforced concrete beam or a steel joist), or this anchorage may take the form of a line of short steel sheet piles. In certain cases, it may even be necessary to employ two sets of tie rods at different levels. The steel sheet piles act as a partly built-in beam BD, articulated at D and having a cantilever portion DA. These piles withstand both bending moments and shearing forces, and therefore they must have a section modulus proportional to the span. This has resulted in the makers of steel sheet piling developing a wide variety of sections and thicknesses, of which the section modulus is close to the calculated value.

The anchored type of steel sheet piling wall must satisfy the following requirements:

(1) It must have adequate fixation in the ground;
(2) There must be anchorages and props of sufficient strength at suitable levels;
(3) The section modulus of the piling must be sufficient.

It is often difficult and sometimes impossible to satisfy these three conditions. In certain cases, the ground may be too hard to permit pile driving, whereas on the other hand its low angle of repose cannot provide the necessary passive resistance nor adequate support for the base of the piling. In other cases, there may be no possibility of obtaining either anchorage or propping, which applies particularly to cofferdams employed for ship salvage or for the construction of works in the bed of a river; it may therefore be that the calculated section modulus is greater than that provided by the heaviest of existing sections.

It is above all necessary to emphasise that even in the case where this procedure can be applied, its weakness arises from the anchorages. These lead to complications: tie rods threaded at the ends, couplings, fixed joints, braces, anchor plates and so forth, the manufacture of which demands the help of specialised skilled steelworkers. The material required is costly and manufacturing delays are generally prolonged. It is often necessary to arrange the tie rods low enough to reduce the unsupported span. This may result in the rods being below water level, thus making their erection extremely difficult and also losing the inherent benefit of piling in the avoidance of all submarine work.

These problems have stimulated thought on the development of the well established system of a double line of sheet piling, as shown in Fig. 1. The procedure originated in the U.S.A. in 1910 with the salvage in the dry of the American cruiser, *Maine*, sunk in 1898 during the Spanish American war in the roadstead of Havana, Cuba, where she rested on the sea bottom at a depth of 36 feet.

A cofferdam of oval form in plan was constructed around the wreck, as shown in Fig. 3, comprising cellular cylinders of sheet piling 49 feet in diameter, which were filled during their construction with clay taken from within the cofferdam. Each cylinder had sufficient stability both from its own weight and from the weight of its filling to retain the external water pressure without any strutting at the top. The sheet piles used were of the American Lackawanna type, 75 feet long, in two parts joined by fish-plates. The employment of clay as filling was not very fortunate because of its tendency to dissolve in the water. It was therefore necessary to dump rocks within the cofferdam and at the bases of the cylinders in order to obtain the required support for the piling.

The proposed salvage operation was completely successful. Construction of the cofferdam took less than four months, and the cruiser was repaired in the dry and was able to be refloated after the cylinders of sheet piling had been removed. However, after twelve years of immersion, the wreck

* Translated from French by Rolt Hammond, A.C.G.I., A.M.I.C.E.

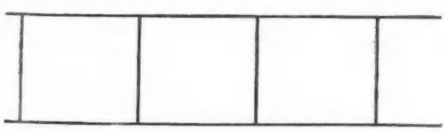


Fig. 1. Wall of two parallel lines of sheet piling with bulkheads.

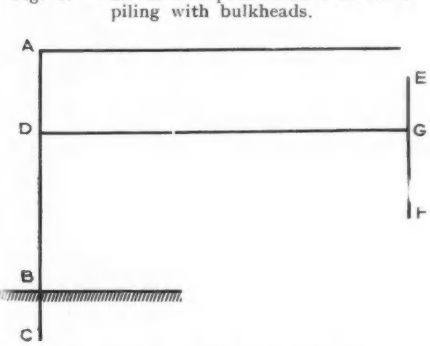


Fig. 2. Sheet piling with anchorage.

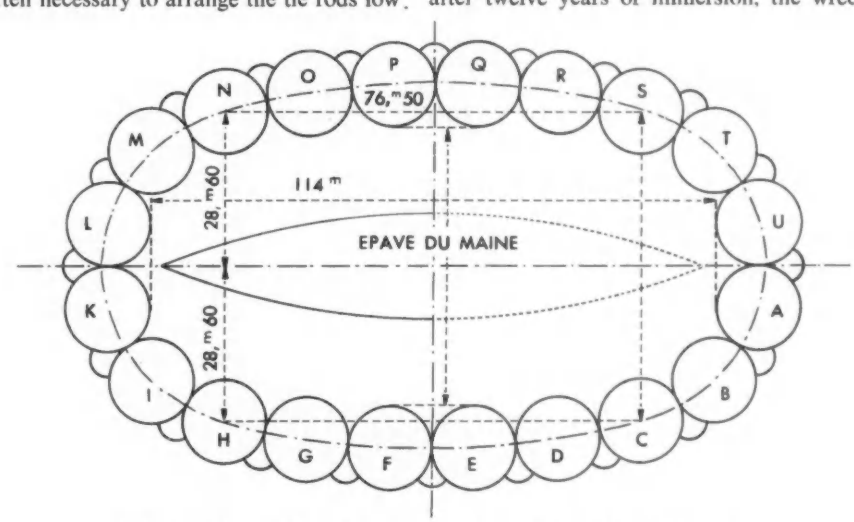


Fig. 3. Plan of the cofferdam for salvage of the *Maine* in Havana.

The Application of Cellular Piling—continued

was no longer serviceable and it was therefore towed out to sea and scuttled. The system of salvage employed was revolutionary at that time, but since then both temporary and permanent works have been constructed with the aid of cellular piling.

The procedure consists essentially of retaining soil—an exceptionally economical material—which derives stability from its own weight and requires neither anchorage nor strutting. The steel sheet piles merely retain the soil and prevent it from spreading.

The basis of this form of construction is the "gabion". This is formed of a periphery of sheet piling either of circular or semi-circular form, filled with material having, if possible, a high angle of repose, such as gravel and sand. It is by the weight of its filling that the gabion withstands the horizontal or inclined thrusts to which it is subjected. The friction of its base on the soil resists all sliding, and the driving of the piles into the ground, which is not theoretically essential, provides further security in this respect. A gabion can also support vertical loads, the surrounding steel sheet piling greatly increasing the compressive strength of the retained soil.

All bending moment on the piles is eliminated, due to the circular form, and their tangential strength is developed under conditions analagous to that of a pressure conduit or a sack of earth.

A gabion can be used on its own, as shown in Fig. 4, in which case it must be of completely circular form, and may be used for the foundation of an aerial cableway or of a lighthouse. The piles can equally well serve as a crib for the subsoil on which the load from a foundation tends to cause excessive deformation.

In Figs. 5 and 6 we have an example of how this cellular piling system is applied in most cases, the cylinders being reinforced by further lines of sheet piling driven to form the arcs of circles. The system can also be arranged as shown in Fig. 7, using transverse bulkheads and retaining the circular form for the sides and ends of the work. Cellular construction of this type is useful both for temporary and permanent works, either in rivers or in the sea, such as quay walls, docks, jetties, dams and lock walls. Isolated cylinders can be used as supports for reinforced concrete or steel structures.

The cellular arrangement is relieved from the triple force applied to anchored steel sheet piling, in that it does not require either anchorage or strutting and the piles do not have to withstand bending moments. Since the depth to which the piles are driven can be reduced to a small amount in most cases, it may be necessary in certain instances, such as cofferdams, to drive the piles to an impervious stratum and thereby to prevent water from entering the cofferdam beneath the piling and undermining the structure.

In most cases the cellular method permits the works to be used as construction proceeds. The finished structure has sufficient elasticity to absorb the shocks imposed by ships; and it is possible to use piles in two

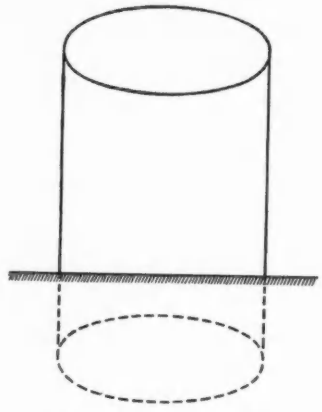


Fig. 4. Isolated gabion.

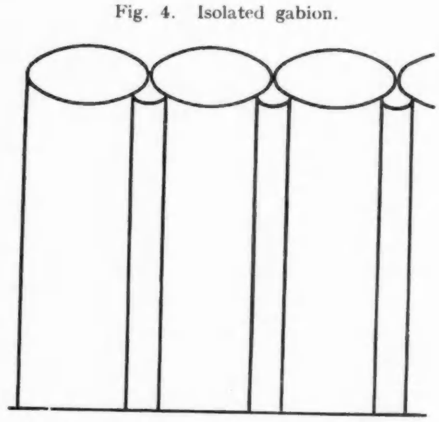


Fig. 5. Elevation of circular abutting cells.

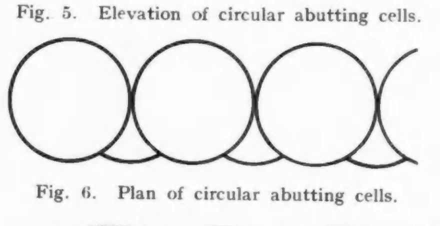


Fig. 6. Plan of circular abutting cells.

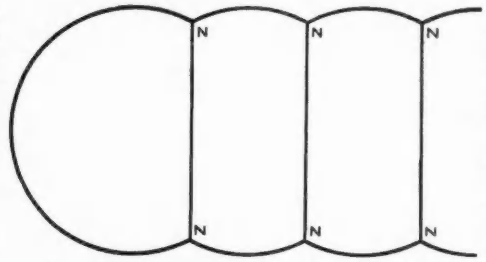


Fig. 7. The cellular system in conjunction with straight transverse bulkheads.

lengths joined together by fishplates, thereby easing the transport of long piles needed for large works. Moreover, the length of piles may be increased after driving, and a breach in a dock may be readily closed by using the lower part of the work in the form of gabions to provide a sill in order to eliminate undermining.

This procedure is possible because the piles are not subjected to bending. The joints between the lengths of the piles can be arranged in the same way as brickwork, at different levels. With the cellular arrangement only shallow driving of the piles is necessary, and all uncertainty about the permissible working stress on the foundation is eliminated. Since bending stress on the piles does not occur, it is necessary to calculate the section modulus to resist bending only for certain forms of undulated sheet piles.

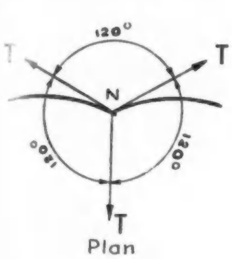
At first sight, it may appear that the cost of the cellular design is higher than that of straight parallel piling because of the greater length caused by curvature, but it is not as simple as that. Although undoubtedly the area of piling in the cellular system may be greater, the tonnage used may be considerably less, since the sections employed are of flat plate, and are therefore lighter than an equivalent undulated section. Furthermore, even though the tonnage may be slightly greater than in the case of anchored sheet piling, the cellular arrangement still remains more economical because anchorages are eliminated with their attendant high cost and difficulty.

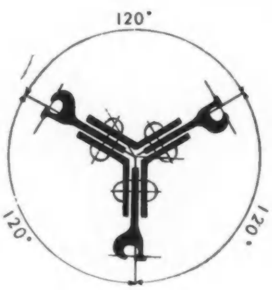
For high retaining walls, it is claimed that the cellular method is the only possible solution. The advantage of the cellular design as compared with the straight anchored type of sheet piling is more marked as the height is increased. In each particular case, there is a height below which the straight type of piling is more economical and above which the advantage lies with the cellular design. The evaluation of this limiting height can only be determined precisely in relation to the cost of the piles, the material available for anchorage, and the cost of filling.

There are several types of the lightest flat sections available for works of shallow depth, and these light sections contribute towards lowering this limiting height in favour of the cellular form of construction for this class of work. It is thus possible to choose between the designs shown in Figs. 6 and 7. The straight bulkhead design depicted in Fig. 7 is generally more economical because it has less area of piling. However, it is essential that the cells should be filled in such a manner that the level of filling on each side of the transverse bulkhead is the same, because otherwise the bulkheads will tend to be curved and will remain thus under the action of earth pressure. The design shown in Fig. 6 is relieved from this handicap, which enables that part of the work already filled to be used sooner than would otherwise be possible, and it also eliminates the danger of the bulkheads being damaged in stormy weather before the filling has been completed.

Certain essential qualities are necessary for steel sheet piling used in cellular structures. The section must have high tensile strength, which depends upon the thickness of the web, and the breaking strength of the joint. This latter strength should be guaranteed by the manufacturer, because ultimately the entire strength of the work depends upon it. Piling for this work must have a flat web, because there is considerable risk of

The Application of Cellular Piling—continued





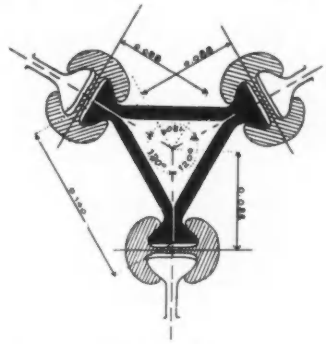


Fig. 8 (above), Fig. 9 (centre) Plan of junction between cofferdam walls in cellular construction, using conventional riveting. Fig 10 (right) Senelle triangular joint formed for a specially rolled section.

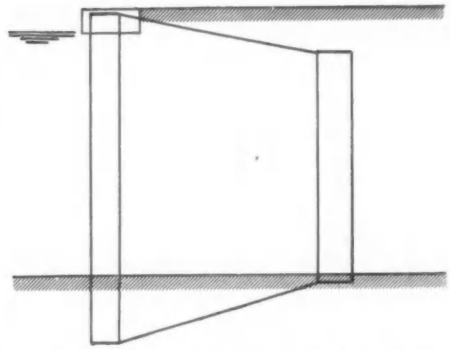


Fig. 11. Cross-section through cellular type of quay wall, showing possible reduction in height of rear portion.

deformation with an undulated section, since the tensile stress tends to straighten these undulations.

When selecting filling material, it is an advantage to use that which has a high angle of repose in order to reduce earth pressure and therefore tension in the piling. Mud and clay should be avoided, because the former gives very high pressures which approach hydrostatic values, and the latter tends to dissolve in water. Gravel, rock debris, dredged material, sand and quarry waste are all excellent filling materials. Their cost is often reduced merely to that of transport, in which case the choice will be determined by local conditions. Concrete has sometimes been used for filling. It is not recommended because of its high cost and its rigidity limits the elasticity of the structure, which is so valuable for absorbing shocks, such as those imposed by ships. Various methods can be used for placing the filling, such as by lorries or wagons, by grabs from barges, or even by pumping.

The forces acting on the structure shown in Fig. 7 are indicated on Fig. 8. At each point N there are three equally spaced tensile stresses of tangential and direct character respectively. The two tangential stresses are resisted by the direct tensile stress acting along the transverse bulkhead. It is therefore essential that there should be no weak point at the junctions N.

In most piling systems, these junctions take the form shown in Fig. 9, in which three lengths of sheet piling have been cut longitudinally along the centre line, being joined together by three sets of fishplates using rivets, bolts or welding. Weakness in the web caused by rivet holes, results either in excessive stress in the metal, or leads to wasteful thickening of the web. The rivets which are simultaneously subjected to shear, bending and tension, work under the worst conditions. In short, this design is expensive.

The Senelle triangular joint shown in Fig. 10 is a special section rolled in France by the Société Lorraine-Escaut. It has a minimum breaking strength of 16,800 lbs. per lineal inch and is claimed to provide the necessary requirements without assembly by riveting, bolting or welding. It has the further advantage that it does not introduce any weak point because there is equal distribution of stress at each apex of the triangle.

In the case of the bulkhead type of design shown in Fig. 7, where this is employed, for example, for a quay wall, it is possible to reduce the height of the rear portion, as shown in Fig. 11, because the transverse bulkheads perform the function of anchorages.

We shall now briefly review some important works carried out by the cellular method of construction. Fig. 12 is an excellent example of the bulkhead type of construction (Fig. 7); this is for the quay wall of Doniambo, New Caledonia, carried out in 1937 with 1,380 tons of steel sheet piling, in lengths ranging from 47 to 56 feet and incorporating the Senelle triangular joint of the type already described (Fig. 10).

A dolphin at the port of Le Havre, France, is shown in Fig. 13; this was constructed in 1938 to serve as a mooring for the liner *Normandie*. This is an isolated cylinder 39-ft. 6-in. diameter, constructed of Senelle steel sheet piles 79-ft. long driven into the subsoil to a depth of 19-ft. 8-in. and filled with dredged material. The cylinder was constructed in the dry on timber staging,

Fig. 12 (left) Quay wall under construction at Doniambo. Note the line of Senelle joints on the right connecting the curved piling with the straight bulkheads. Fig. 13 (right) Dolphin constructed at Le Havre, France, as a mooring point for the *Normandie*.

The Application of Cellular Piling—continued

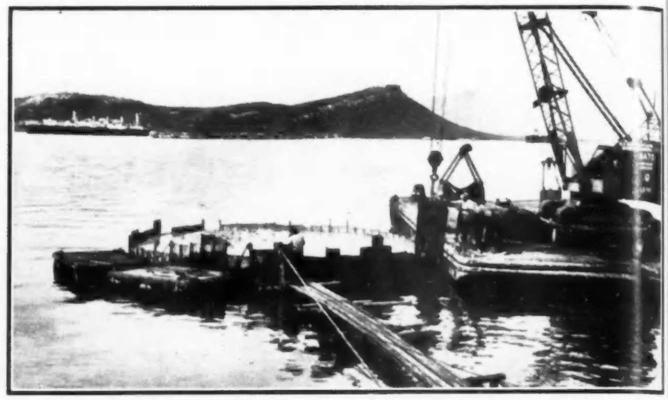


Fig. 14 (left) Dock wall at Laninon, Brest, constructed with Bethlehem steel sheet piles in conjunction with Senelle triangular joints. Fig. 15 (right) Dolphin under construction in Curacao, Dutch East Indies.

and the whole assembly weighing about 155 tons was transported to the site by a large floating crane. The cylinder was filled hydraulically.

The dock wall at Laninon, Brest, is shown in Fig. 14; this is 1,150-ft. long and 79-ft. high and was erected for carrying out the repair and modernisation of the repair basins. This wall has been constructed on the transverse bulkhead cellular principle. At that time (1946), shortage of steel in France compelled the French Navy to use Bethlehem steel sheet piles imported from the U.S.A. Nevertheless, the requirement that there should be no weak point in the structure led the French Government to use 500 tons of Senelle triangular joints, which were employed in conjunction with the American sheet piling.

The gabion method of construction was used during the rebuilding of the port of Dunkirk; docks III and IV and the Trystram lock gates required more than 6,000 tons of Senelle piles. Isolated cylinders of the same sheet piles were constructed for permanent works like the armament quay of the Ateliers et Chantiers de France and moorings for small and large oil tankers. In each case the cylinders served as foundations for concrete decking.

Fig. 15 shows work in progress in the Dutch East Indies. This was carried out between 1949 and 1953 and included the following projects, namely: a mole; a quay formed of 24 sheet piled cells; an oil tanker quay of 16 cells; several dolphins; and other permanent works, for which about 7,000 tons of Senelle piles were used.

At Spezia, Italy, a tanker jetty was constructed for the Italian Shell Company. This permanent structure consists of five supports in Senelle piles, comprising three isolated gabions and two groups each of three cylinders. These were designed to resist mooring shocks and to receive reinforced concrete decking supported by piles. There are about 1,000 tons of Senelle piles ranging in length from 69 to 79 feet. At La Seyne, near Toulon, there is a permanent quay consisting of 45 cells constructed of Senelle piles 43-ft. long and having a total weight of 2,800 tons. The transverse bulkheads are 39-ft. long and are spaced at 31-ft. centres. The beams supporting the crane tracks rest directly on these transverse bulkheads through the medium of a reinforced concrete spreader beam.

Dock Labour Report for 1954

Modification in Labour Policy

The Eighth annual report of the National Dock Labour Board records that in pursuance of its previously declared policy, the board has sought to maintain close control over the size of the labour force to ensure that variations are related to the amount of work to be undertaken.

The sanctioned strength was reviewed in the spring, and again at the end of the year. On the former occasion, on the advice as to future prospects, it seemed possible that there might be some falling-off of employment towards the end of the year. For this reason, and in the light of current experience, a number of variations upwards and downwards in the sizes of local registers were approved, the net effect of which was to reduce the overall sanctioned strength from 74,910 to 74,700.

When informing local boards of these changes, the national board paid tribute to their co-operation in keeping their labour forces at the lowest limits consistent with normal labour requirements, and the board's obligation to the industry; this co-operation justified modifications in the labour policy, comprising:—

(a) The lifting of the standstill order on fresh recruitment to main registers;

(b) Authority to local boards to recruit, as required, up to the revised sanctioned strength, and to establish in each port temporary registers not exceeding 5 per cent. of the number of daily workers on the respective main registers for each occupation.

The prior approval of the national board continued to be required where (a) any additions to the register, whether to replace wastages or otherwise, were contemplated in any port in which, during the first quarter of 1954, the surplus labour averaged more than 25 per cent. of the workers' register; (b) it was desired to maintain or establish a temporary register after the end of the annual holiday period; (c) it was desired to establish in any port a temporary register in excess of 5 per cent. of the number of daily workers in a particular occupational group.

A second review of the sanctioned strength was undertaken in December, by which time it was apparent that earlier fears of a slight recession had not materialised, though it was difficult to determine the extent to which the high level of employment was attributable to the consequences of the recent strike. However, on the strength of the information available, a number of further adjustments were made, whose net result was to increase the sanctioned strength for the main register to 76,050; additionally, authority was given for 2,130 men on temporary registers in 15 local board areas.

Expansion of Temporary Registers.

There has been a welcome extension of the use of temporary registers as a means of meeting short-term requirements. For example, throughout the third quarter of the year the total of temporary workers averaged 1,990, which helped considerably in offsetting the temporary loss of workers from the main registers due to annual holidays.

The probationary aspect of temporary registers is also worthy of comment; 1,430 men admitted to main registers during the year had previously served in a temporary capacity, as compared with 185 in the previous year. This development has been particularly timely, since it has enabled local boards to exercise a measure of selection when filling vacancies and has ensured that a number of the men admitted to the main register had obtained preliminary experience in the industry.

Dock Labour Report for 1954—continued

The figures for intake call for no particular comment, since they are the numerical expression of the amount of recruitment which was found necessary. Although outflow has apparently increased slightly above the level in 1953, it should be noted that this is more than accounted for by the increased use of temporary registers; the number who left the industry of their own account was somewhat greater than in the previous year, no doubt as a result of the opportunities offered by the present period of full employment.

Taking the main register as a whole, the average age of workers increased very slightly during the year from 46.3 to 46.4 This is, however, not the whole story for, since the previous survey, there had been a welcome expansion in the sizes of temporary registers, and concurrently the average age of temporary workers fell from 35.0 to 31.1 years. It follows, therefore, that apart from their other merits, temporary registers have been the means of introducing some much needed younger blood into the industry.

There has been a considerable increase in the number of man/days lost through labour disputes, the total of 714,569 being much in excess of that for any other year since the inception of the present scheme; over 90 per cent. of this total was attributable to the dispute on the overtime ban, in London, in October, and to the supporting action which followed at a number of other ports. The stoppage in Hull over the discharge of grain cargoes by hand scuttling methods lasted for 10 days, and cost over 20,000 man/days. The balance of the time lost was due to miscellaneous local stoppages of brief duration.

Training Facilities.

The closer relationship between the general level of dock work and the available labour force has emphasised the need for specialist training to remove the risk of men being left in idleness from time to time through a lack of adequate numbers of crane drivers, checkers, or other key personnel. The board has, accordingly, accepted responsibility for the cost of training such specialists under schemes arranged locally, and it was mainly on this account that the expenditure under this heading rose from £1,457 in 1953 to £3,476 in 1954.

New developments in this field have been schemes for the training of deal porters in London and Hull, which were worked out with the interested parties in the course of the year. The details of these schemes vary somewhat to meet local circumstances, but in each the board has met the costs while trainees were engaged on non-productive work.

Training in London will be undertaken by the Port of London Authority at the Surrey Commercial Dock, and it is hoped to make a start in time for the 1955 timber season; in Hull, the training is undertaken by a number of the timber importers, and a start was made on a small scale at the end of the year, as the result of which an additional 36 men were brought on to the main register for use, primarily, on deal portering work.

The prospect of a period of more steady employment implying continued recruitment has encouraged the board to give further consideration to the discharge of its statutory responsibility for the general training of new entrants to registers. With this in mind, visits were made to Amsterdam, Rotterdam, and to the Royal Engineers Port Training Regiment at Marchwood, from which valuable information was gained as to the facilities and equipment available and the training methods employed.

These visits were closely followed by consultation with the Liverpool local board on the possibility of introducing an initial training scheme in that port. The Liverpool proposals, which had been worked out in some detail, were primarily envisaged to meet local needs, but it soon became apparent that they were capable of more general application. The board accordingly commended to the National Joint Council the introduction of an experimental pilot scheme for the training of new entrants, with a view to its subsequent extension on a national basis. The National Joint Council accepted this recommendation and, by the end of the year, a joint sub-committee had been set up to examine the practical aspects.

Operating Costs.

As regards costs of operation, the report states that the improvement in the level of employment and increased rates of pay brought total wages to £37,799,000 in 1954, compared with £35,830,000 in 1953. Correspondingly, there was a reduction of £486,082 in payments of attendance money and guarantee make-up; in consequence, the total operating costs expressed as a percentage of the gross wages of daily workers fell from 15.8 per cent. in 1953 to 13.5 per cent. in 1954.

Maintenance Scheme.

In view of the steady increase in the number of its properties, the board has reviewed the arrangements for their proper management and maintenance. To fulfil these two purposes, authority was given for the establishment of a small estates department at head office, and the appointment of two travelling building surveyors. Approval was also given to a scheme for the maintenance and repair of the board's properties, providing for budgetary and technical control of expenditure under these headings, with an annual programme of works to keep the board's buildings up to the required standards.

As the result of the initial surveys conducted by the technical staff in 1954, it was found possible to bring the maintenance scheme into effect at the commencement of the present year.

The expansion in the board's technical staff has also enabled closer supervision to be exercised over the course of building construction to ensure that requirements are met, and approved expenditure is not exceeded. With this in mind, consultations with the Royal Institute of British Architects resulted in a standard form of agreement for use by local architects appointed by the national board, which affords reasonable safeguard to the board as building clients within the accepted terms of professional practice. This agreement has been adopted for use on all new building works.

The board has, from the start, regarded its medical service as available in cases of need for all workers on the docks, and the small token contribution hitherto sought from their employers has not been related to the board's costs. It has, however, been found in practice that a disproportionate amount of clerical time was being incurred in bringing these sums to account, and the board has accordingly approved the principle of inviting block grants from other port users on an annual basis. The initial response indicates that this arrangement commended itself to the majority of employers.

Strengthened Financial Position.

During 1954 the board's financial position was strengthened and consolidated. At the outset, income and expenditure seemed likely to be adversely affected during the second half of the year, for which the traffic prospects were uncertain. In the event, the overall volume of employment increased and, despite the controlled expansion of the workers' register, the average numbers of men proving attendance fell by some 3,000 to 4,406 men a day, the lowest figure so far recorded. In consequence, the board's income from percentage payments was much higher, and its expenditure on attendance money and guarantee make-up was much lower than had been expected.

The board is satisfied that, unless there is an abnormal and unexpected disturbance of the average level of employment, the rates as reduced in October can be maintained despite the increased rates of attendance money and guaranteed weekly payments announced early in 1955 and the additional contributions to national insurance which are payable on and after June 6 next.

The adjustments in the rates of stable levy were expected to reduce the board's income by some £140,000 in 1954 and £600,000 in a full year. The board's actual income from percentage payments fell during the last 12 weeks by an average of £8,659 per week (or, say, £104,000 for the 12 weeks). This period, however, included three of the four weeks affected by the "overtime strike"; and though overtime working to clear the affected ports produced enhanced wages and revenue in the subsequent weeks, reliable comparison is not possible.

Out of a total income of £5,048,548, a sum equivalent to a levy of half per cent. on the wages of all registered workers — i.e. £188,994—was, as previously, transferred to the general welfare fund, and was more than sufficient to cover the board's welfare expenditure for the year.

The costs of operating the scheme fell by some £1½ mn., compared with 1953, the reduction being almost entirely due to the lower cost of attendance money and guarantee make-up noted above. The remaining variations were due to fluctuations in registers and labour requirements and/or to changes in basic charges.

Commodity Infestation in Ports

IV.—Some Typical Insect Pests

By W. McAULEY GRACIE
(Director and Chief Adviser of Disinfestation Limited).

One is faced with a real problem when considering the manner of approach to the very wide question of insect infestation in stored products. The subject is so vast, the number of kinds of insects so great, and their life cycles, food preferences, and their susceptibilities are so varied that the attempt to give a clear bird's eye view in an article of the length of the present one will certainly tax the lucidity of the present author as well as compel the jettisoning of much interesting and instructive detail. All will be well if the reader will be so good as to realise and accept it that in the process of controlling infestation in stored products, the omitted detail is highly essential to the actual controller and, indeed, his reputation for skill must depend primarily on his possession of this knowledge. Some hundreds of species included in about thirty-four families in the insect world have been found on stored products in various parts of the world, and additions to the number are being made constantly. In this article there will be no attempt to deal with the characteristics of each species, but a few of the specially important ones will be referred to individually.

Generally, it may be taken that insect pests in stored products and in their storage accommodation belong to one of the following eight categories:—

Species which:

1. Consume the product or one of its constituents. That group includes all the major food pests.
2. Live on moulds or other fungi growing on stored products or on the floors, walls, etc., of the warehouses.
3. Are predators or parasites.
4. Live on dead or injured insects or on the corpses of small animals or birds.
5. Live on fæces, particularly mouse and rat droppings.
6. Normally penetrate into woodwork of buildings and packing cases.
7. Attack crops and emerge during storage of the harvested food; and
8. Are casual insects on products and in storage structures.

Some insects may fall under two or more of the foregoing categories. It is of the first importance that species and sub-species of insects should be correctly identified, as otherwise their capacity for food destruction may be wrongly valued, and the efforts at their extermination may be ineffectual in view of their varying resistances. In certain stages of development it is far from easy to make a precise determination in ordinary working practice until a further stage in the development throws up differences only observable under the microscope. The more that the expert knows about the differences between sub-species and between developmental stages, the more he finds need for making microscopic examinations. The layman who claims to be able on sight to identify insects, as closely as the need for control exists, is in danger of misleading himself, and what is more important, of giving misleading information to others probably more directly concerned. In the present connection, considerations of space must limit attention to members of the groupings of:—

(a) Weevils.
(b) Flour beetles.
(c) Khapra beetles.
(d) Spider beetles.
(e) Moths.
(f) Mites.

(a) Weevils.

There has been much loose application of common names of insects to kinds other than those for which the particular names are intended. The most extreme case of this mis-description is the use of the words "weevil" or "weevily" to denote any kind of small beetle in food commodities. Those who have the duty of clausing documents should be careful to avoid the use of these words unless they are sure that the particular insects are weevils or that the condition of the commodity is correctly described as weevily. There are many kinds of weevils, but they are chiefly distinguishable from other beetles by the prolongation of the mouth parts into a more or less elongated snout. The size of the different weevils depends in some degree on the size of the kernel of grain on which the particular beetles feed. Thus the weevils which attack millet are smaller than those which attack corn. The weevils use their elongated snouts to bore through the tough seed coat of the grain to reach the endosperm. In addition to its usefulness in reaching the more desirable food, the snout is employed to excavate a long slender cavity in which the egg is deposited. The female plugs the hole in such a way that it is practically impossible on ordinary examination to see where the egg has been placed. Hatching into a small fleshy white grub occurs in a few days, and the grub finds itself surrounded by nutritious food. The grub consumes the walls of the cavity while completing its growth, and then changes to a pupa and finally to an adult beetle which cuts its way out of the grain.

The period of development from the newly laid egg to the adult weevil is about four weeks and many female weevils are capable of laying several hundred eggs. The shelter within the grain available to the insect in its developmental stages is a great protection against enemies and destructive changes in temperature, and also is the special reason for close and frequent inspection of grain stocks which are liable at short notice to be found swarming with weevils following emergence.

The two most destructive kinds are the grain weevil (*Calandra granaria* or *Sitophilus granarius*) and the rice weevil (*Calandra oryzæ* or *Sitophilus oryzæ*). These particular insects have world wide notoriety for their capacity to do large scale damage. The rice weevil is about $\frac{1}{8}$-in. long, the grain weevil is slightly larger. The grain weevil is unable to fly. Its membraneous hind wings are weak and functionless and lie under the tough fore-wings, elytra, which serve as wing covers. In warm countries, the rice weevil flies into the fields to lay eggs in the ripening grain. Weevils are dark brown in colour and the rice weevil has the distinguishing signs of four lighter reddish areas, one in each of the four quarters of the elytra. The rice weevil is not so well able to withstand low temperatures as is the grain weevil, and this has a bearing on its distribution.

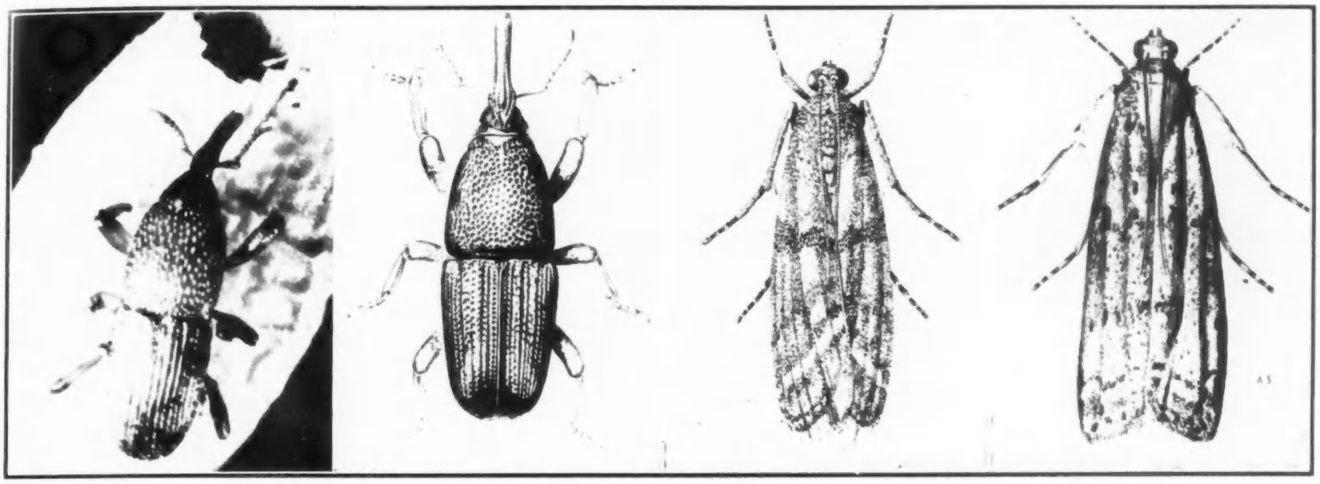
It is quite misleading that *Calandra oryzæ* should be known as the "rice weevil" as it, like the grain weevil, is a serious pest of all grains. It happens to be so called because it was originally discovered in a parcel of rice.

In its capacity for damage the weevil is distinguishable from any other kinds of insects because the adult beetle shares destructiveness with its larvæ, whereas in the case of moths for example, the larvæ do the damage. Holed grain in a cargo or store may already have supported one generation of weevils, if not more. The original excavation by weevils also opens up the way for attack by other kinds of insects which, of themselves, could not penetrate the jacket of the grain, and must perforce maintain themselves by scavenging.

(b) Flour Beetles.

Chief among these scavengers are the flour beetles, i.e., *Tribolium castaneum* (the rust red flour beetle) and *Tribolium confusum* (the confused flour beetle). These are two separate and distinct species, but as they have close similarity in appearance and habits it is convenient to consider them together. These beetles do not normally attack whole grain, but wait for it to be broken down by boring insects or mechanical action. It is for this reason that they are the camp followers of the weevil army. They also are usually found in milling machinery and in all kinds of grain products.

Commodity Infestation in Ports—continued



Reading from left (1) The Grain Weevil *(Calandra granaria)*; (2) The so-called "Rice" Weevil *(Calandra oryzæ)*. Note the elongated snout at the front of which are the mouth parts. The egg and grub stages are spent within the berry of grain, from which the adult form emerges ready for mating. The grain may be quite hollowed out in fattening up the grub; (3) The Cacao or Tobacco Moth *(Ephestia elutella)*. A great pest of cereals etc. throughout the world; (4) The Flour or Mill Moth *(Ephestia kuhniella)*. The moth that can bring milling machinery to a standstill, and ruin "bolting" cloth.

In certain trades they are known as "bran bugs," while on ships they are often called "ships' ants." They are very common pests in food stores as well as in cargo spaces.

Tribolium castaneum (the rust red flour beetle) is more often met with in ships, and *Tribolium confusum* (the confused flour beetle) in milling machinery, although both are common in either place.

The adult beetles are reddish brown and about 1/7-in. long. The larvæ are yellowish caterpillars, ¼-in. long when fully grown. The two kinds of beetle are of flat shape with parallel sides of the body. The main readily observable difference between them is in the shape of the tips of the antenna or feelers. The outer three segments of the feelers of *castaneum* have a more pronounced club-like appearance than those of *confusum*. Incidentally, the confused flour beetle owes its name to the fact that originally it was difficult to distinguish from the rust red flour beetle *castaneum*. *Tribolium confusum* is better able than *castaneum* to survive at low temperatures, but on the other hand, *castaneum* may become an active flier under warm conditions, and in this respect has the advantage over *confusum*. These insects are more common than any others in ships, granaries, mills and warehouses, and are recognised as the worst insect pests of flour and other farinaceous food. They do not limit their activity to these foods, but are to be found in a wide range of commodities which in the course of trade have received the infestation during storage, transport or processing.

A built up *Tribolium* infestation in grain is a special cause of advanced heating and destruction, which in its primary stage may have originated from other influences on the grain.

A very unpleasant characteristic of *Tribolium* is its capacity for ejecting a nasty-smelling fluid which, where the infestation is heavy, imparts to the food an unwholesome pungent odour. Incidentally, it may be mentioned that the eggs are coated with secretion which causes particles of flour to adhere, thus increasing the difficulty of observing the presence of eggs. The baking properties of flour are affected by heavy infestation. The presence of bright red insect bodies in the processed food is readily noticeable.

As *Tribolium* stands so high in the ranks of food pests, by reason of its objectionable characteristics, it is of real moment that its capacity for increase should be realised. It should be remembered that the size of an infestation is not apparent to the casual observer. Few insects may be seen on commodity surfaces exposed to strong light, but the unseen yet active population may be very great. This difficulty of assessment is in some measure responsible for the extension of damage and the greater complication of remedial action.

Other secondary pests of grain and flour are:—

Læmophlœus, which is capable of penetrating the seed coat covering the germ of soft grain and of devouring the germ itself. This insect is commonly known as the flat grain beetle.

Rhyzopertha dominica (lesser grain borer, hooded grain borer). This is a very small insect, being only about 1/10-in. long, but in status it is a major grain pest. The head of this beetle is tucked under the chest. The female may lay from 300 to 400 and even up to 600 eggs, which hatch out in five to twenty-six days, according to temperature and other conditions. The larvæ chew their way *into* grain, which becomes hollowed out, and indeed this particular insect removes all the endosperm, leaving only the husk of the grain. Fortunately *Rhyzopertha* in this country usually cannot survive the winter unless it is living in a heated commodity or in storage accommodation at high temperature.

Oryzæphilus surinamensus (the saw-toothed grain beetle). We have here again a very small but active beetle of world-wide occurrence. It is about 1/10-in. long and owes its common name, "the saw-toothed grain beetle," to six teeth-like projections on either side of the thorax. Brown in colour, it has a flattened body.

The female may live for anything from six months to three years. Egg laying commences within a week of emergence from the pupa and continues singly or in batches for a period of two to five months to a total of nearly 300 eggs. The hatch-out takes from three to seventeen days and the larva, whitish in colour, has a dark head and bands on the abdomen. The larval stage occupies two to seven weeks and the pupal stage about ten days.

Oryzæphilus is able to survive the winter, even in unheated warehouses. It cannot penetrate sound grain, but is one of those camp followers which attend on the weevils and lesser grain borers and use the exit holes they have made as means of entry into the grains. It is a serious pest of finished products over a wide range, and a neglected patch of infestation may soon result in a distributed infestation throughout the premises.

Gnathocerus cornutus (broad horned flour beetle). We may properly close this section with a reference to the broad horned flour beetle, which is similar in size and habits to *Tribolium* and is found in mills, warehouses, etc., in similar situations. In the male adult, the distinguishing feature is the pair of large horns on the jaws. Both sexes are slightly larger, more sturdily built and more shiny than *Tribolium*. In most other respects that which has been said already about *Tribolium* applies equally to *Gnathocerus*, which is particularly an infestor of cereals.

A special place in a selection of beetles must be reserved for:—

Commodity Infestation in Ports—continued

The Confused Flour Beetle *(Tribolium confusum)*. So called to distinguish it from the flour beetle *(Tribolium castaneum)*, a creature to which it bears close resemblance. The worst insect pests of flour and other farinaceous food.

The Spider Beetle *(Ptinus tectus)*. May be found in almost any food warehouse. The damage they do is truly amazing.

(c) The Khapra Beetle (*Trogoderma granarium*).

This beetle belongs to the Dermestid family, but is one of the few members of that family which do not require food of animal origin, but are able to maintain themselves on a vegetable diet. It is also exceptional in that the adults are very short lived and do not feed or drink. They are simply egg producing factories. The eggs are laid singly to an average number of fifty, a large proportion being laid during the first few days. Eggs hatch in five to nine days and each larva moults from four to ten times.

The tendency is for the larvæ to group themselves in cracks and crevices—they are able to go for long periods without food. The adult is about 1/10-in. long, is medium brown in colour and oval in shape. The larvæ are brown hairy grubs of relatively slow movement.

The beetle is a relative newcomer to the United Kingdom, having apparently been introduced on Indian barley during the 1914/18 war. It is regularly found on imported barley from North Africa, Syria and Iraq, on groundnuts and pulses from India and on groundnuts from Nigeria. It is not surprising, therefore, that *Trogoderma* finds its way to grain and provender mills and to maltings. The newly hatched larva begins feeding on the soft germ of the grain and continues feeding deeper into the kernel as the grub grows. Apart from the damage done to the grain and malt, the main objection is the contamination by the masses of cast larval skins, which are liable to be very irritating to the skins of those handling the grain. The quantity of cast skins is directly related to the large number of larval changes in the development of the insect.

The larvæ are capable of working their way into positions difficult of access, where they can remain for long periods without further development. This produces a serious complication in the control at the larval stage, especially as there is considerable resistance to certain chemicals at that stage. On the other hand, the adults are very susceptible to several chemicals, and measures designed to kill the adults before they lay their eggs would do much to keep the population down.

(d) Spider Beetles.

We must not overlook the great importance of the spider beetles, *Ptinus tectus* and *Niptus hololeucus* (which is also known as the golden spider beetle). Spider beetles are not indigenous to this country, but since their introduction they have become common to practically all food warehouses, where they may cause serious damage, especially to foods of animal origin and those high in vitamin B content. *Ptinus tectus* first was noticed in the United Kingdom nearly seventy years ago, and the indications are that it came from Tasmania in some cargo or other. *Niptus hololeucus* was first reported in the United Kingdom in 1837, and so far as is known, was first discovered in 1835 in Asia Minor.

It is somewhat surprising, in view of the prevalence of these spider beetles in warehouses in this country, that they do not figure prominently in the survey reports on ships' holds. For such minute creatures, the extent of damage they can do is positively amazing. In the case of a large stock of dried yeast in a commodious warehouse, the commodity was found a few years ago to be webbed by the pupal cocoons of *Ptinus tectus* and the fabric of the bags was so damaged by the exit holes of the adults that the bags themselves had broken and caused the piles to collapse. In another case of attack by *Ptinus tectus*, on fishmeal, it was found that after only three months' storage the bags had been so weakened that when they were moved the fabric broke and the contents were spilt on the floor. Spider beetles are commonly found in the fabric of warehouses as the larvæ usually pupate in cracks and small crevices, and because adults disappear into these retreats during daylight. The insect can live and develop in accumulations of organic dust and in rodent fæcal pellets. Both larvæ and adults can over-winter in warehouses, and all stages of the life cycle are generally present in infestations.

The principal form of damage to produce is the lowering of quality due to the presence of live or dead insects, silk and cocoons. Whole grain is seldom seriously attacked. The damage to individual grains is easily recognisable, the bran covering and the endosperm immediately beneath it being eaten off unevenly.

Containers, i.e., sacks, cartons or paper bags, may be holed by larvæ chewing through them, especially when preparing places for building cocoons. Damage to containers by adult beetles, on the other hand, is unusual. Wood, either of boxes or barrels or as part of the structure of buildings, is often damaged by mature larvæ when enlarging cracks or depressions as sites for cocoons. Larvæ cause damage to leather by tunnelling into it. In short, there is not a good word to be said for this very small but certainly not insignificant creature.

(e) Moths.

In Nature there is an order of life known as "Lepidoptera." This long word covers many kinds of small winged insects, and we are particularly concerned with some which belong to a highly destructive range of food moths equipped with two pairs of membraneous wings, the body, wings and appendages being covered with scales. In the adult, the principal mouth parts are in the form of a suctorial proboscis or trunk. The larvæ have well developed heads and three chest and ten distinct abdominal segments. The larval mouth parts are arranged for biting. When the larvæ pass into the pupal stage, the pupa has the legs and wings

Commodity Infestation in Ports—*continued*

secured to the rest of the body by the moulting fluid, the abdomen only being movable. The pupa is generally enclosed in a cocoon.

These food moths are quite tiny and some are of extraordinary beauty, but like many other outwardly attractive creatures, they are to be treated as dangerous enemies.

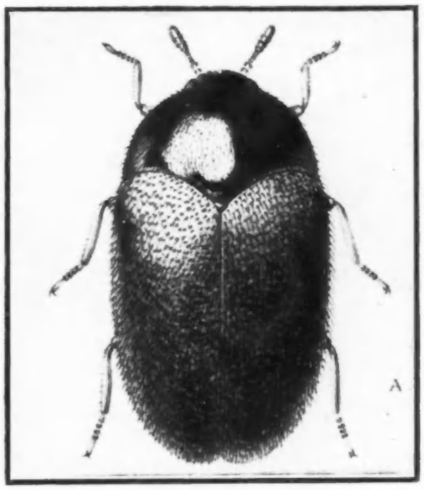
It is necessary that a brief description of the habits of these moths should be given in order that the time and extent of the attack on food may be the better appreciated.

The female moth, immediately after mating, lays eggs in clusters in or on food and these hatch into active larvæ which feed voraciously. The mature larvæ exude a silken thread from behind the mouth parts and trail this is they crawl. Under suitable conditions some moths breed throughout the year but, in general, the winter is passed in the egg, larval or pupal stage, according to species, and in a few species as resting adults. In the larval stage a number of kinds of moth pass into a state known as "diapause," this being a resting state in which development is suspended and only starts again after a long period of quiescence. All the damage to stored products by moths is done by the larvæ, since the adults can only feed on liquids.

Prominent among the moths of economic importance comes a group of *Ephestia*, i.e., *Elutella*, *Kuhniella* and *Cautella*. These three species of the genus *Ephestia* are of great importance as pests of cereals and other food commodities throughout the world. *Ephestia elutella* is commonly known as the cacao moth or the tobacco moth, but although these are favourite diets, *elutella* attacks a very wide range of food. The adults have a very short life and in the course of a few days the female lays up to 120 eggs on food commodities, the eggs hatching out in about ten to fourteen days. The larvæ undergo several moults in the upper layers of the infested commodity on which they are feeding. The first and second instars of the larval life are generally spent inside the embryo of the wheat or other berry, but in the later instar developments, the larvæ move from one grain to another, eating the embryo as they go. One larva consumes 48 wheat embryos in the course of development, and there may be many thousands of them in a single infestation!

When the larvæ are fully developed, feeding discontinues and before seeking secluded places for pupation the grubs wander about for some 36 hours, trailing silken threads and spinning webbing as they go. The quantity of silk they discharge and the amount of webbing they can spin in the form of a counterpane over the commodity are truly amazing. This wandering commences at the end of August or up to the middle of September. Some of the earliest wandering larvæ pupate immediately and adults emerge in September/October, but the majority remain in diapause until prior to emergence in the following May.

The adult moth *elutella* is only 1/3-in. in length, has dull grey wings, with two fairly straight bands across the forewings, the

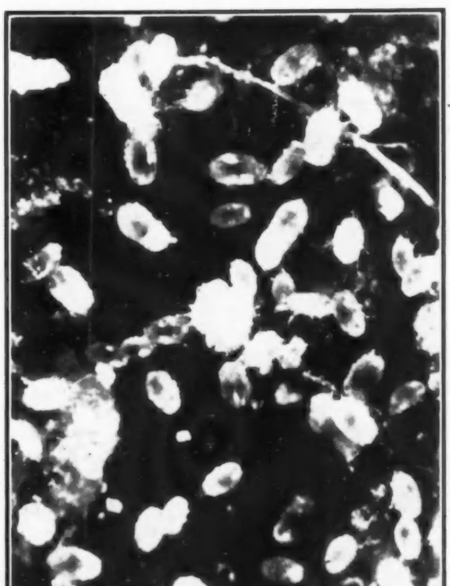


The Khapra Beetle *(Trogoderma granarium)*. Causes great damage to grain and malt. There is contamination and irritation from the cast skins.

larvæ are whitish in colour with black spots and long hairs, and when fully grown are about ½-in. long.

This moth must be regarded as a major pest in the United Kingdom; its spread may be by flight from warehouse to warehouse, or in the course of transfer of commodities carrying larvæ.

Ephestia kuhniella is slightly larger than *elutella*, and is the most important pest of flour, oatmeal and provender mills. The larvæ, by their webbing, may seriously affect the smooth running of machinery, and they may also bite holes in the bolting cloth. Whole grain may be webbed and degermed; cereal products may be webbed and may, if the infestation is heavy and of long standing, acquire a sour and unpleasant odour.



Mites *(Tyroglyphus farinæ)* (much enlarged). A pest of grain, flour, dried fruit etc. Damp storage encourages rapid development.

Kuhniella richly deserves its name as the mill moth.

Ephestia cautella is a particular pest on oilseeds, oilseed cake, cacao, dried fruit, nuts, cereals and cereal products, and is frequently found in considerable numbers in the holds of ships.

These three moths in the *Ephestia* group, while somewhat alike in appearance, vary widely in their preferences, habits and susceptibilities. Correct identification in the several stages in the life cycle is highly essential to the mitigation of food damage attributable to the several creatures in this group.

There are other very destructive moths, but as the emphasis has been placed on correct identification, which involves a considerable degree of skill, it is hardly necessary to detail the whole range of moths. It is for the expert to do the classifying and prescribing on being called in by the owner or custodian of the commodities seen to be infested by moths.

(f) Mites.

Chief among these minute creatures in relation to damage to foodstuffs is *Tyroglyphus farinæ* (the flour mite). This is of microscopic size, pale and soft bodied. It is primitive in structure but is highly important in capacity for damage. Except in warm dry stores the mite, and particularly *Tyroglyphus farinæ*, is the main pest of stored wheat. The reproduction rate under damp conditions is very considerable.

Mites bore into the germ of the grain and feed within. They impart a strong distinctive smell, referred to as "minty," produced in their own surface secretion. This taint in extreme cases may be carried right through to the finished flour. In long standing infestations mites extend the damage by penetrating the epicarp of the grain and destroying the embryo before going for the endosperm. In the result, all that may be left will be the husk, containing a cluster of mites.

Mite infestation is a clear case in proof that prevention of the conditions conducive to mite infestation is the greatest possible contribution to clean and wholesome food. It is also true that it is far easier to acquire mite infestation than to remove it. Indeed, there is no more difficult pest to combat.

Let it be remembered that at the commencement of this article it was explained that the contents would be confined to references to some typical insect pests and the article itself was not intended to go beyond this—nor, in fact, has it done so. Many other insects of great interest and economic significance to food trades have not been touched upon. What has been said is surely sufficient to emphasise the great breadth and complexity of the problem of food infestation by insects.

(*to be continued*)

Hydraulics Research

Board's Report for 1954

Surges in the Thames.

One of the most important investigations described in "Hydraulics Research, 1954," is concerned with the behaviour of storm surges in the Thames Estuary. Particular attention was given to the effect that flooding bankside areas in the lower estuary might have on water levels at high tide in London. It was found that the effect of flooding in the surge of 1953 was comparatively small. When the effect of a surge 18-in. higher at Southend was investigated, it was found that although bankside spill would have reduced the maximum level at London Bridge by 15½-in., the level would still have been 8½-in. higher than the 1953 surge. Bankside spill, however, could not be allowed in any considerable part of the area.

Only two alternatives to prevent surges in London were left. One was to raise embankments, wharves, warehouse floors and so on, and the other was to build a gated structure across the river which could be closed before the predicted time of arrival of a surge. The hydraulic characteristics of various types of structure are being investigated at the Station and experiments are also being carried out on the Port of London Authority's Thames Pilot Model. They show, so far, that a barrage would be effective in preventing flooding in London and that it would not raise the water levels downstream.

Silting at Tilbury.

Silting in Tilbury Docks is another problem on the Thames which the Station has been investigating. Approximately 80 per cent. of the silt entering the docks does so during spring tides. During these tides the water level in the river is higher than that in the docks. It causes the lock gates to swing open and the inflow of water carries a high concentration of mud. The Port of London Authority was recommended to impound the docks to a higher level. Alternatively, "run-in" might be prevented at the Old Entrance but allowed to take place at the New Entrance, where the river water carries less silt. A device which held the lock gates shut would greatly reduce the amount of dredging required in the docks.

Radio-active tracers, consisting of "labelled" glass, ground to the same size as Thames mud, have been used in an experiment to discover if the method was a possible one for tracing the movements of mud.

Problems of Lyttleton Harbour.

Work has continued on the behaviour of the proposed extensions to Lyttleton Harbour in New Zealand. The first was shown to produce higher waves than those in the existing harbour. The protection given, however, was considered acceptable because the new harbour would be used by much larger ships. The second scheme produced waves three or four times as high and was condemned as inadequate. On the other hand, the first scheme would require much more dredging than is done at the harbour now, but the second only a little more. A third type of extension is now being investigated.

Harbour Entrance at Southwold.

Experiments on the model of Southwold Harbour have included the use of a self-propelled model boat. To find out what were the wave effects on shipping entering and leaving the harbour, the boat was photographed with a slow motion camera. The investigations are aimed at modifying the present harbour so that waves cannot reach to its upper end, thus allowing the ferry service to re-open. The harbour would be improved for navigation by increasing the depth of the water and reducing wave action in the entrance. At the moment conditions there are hazardous to small boats. There are also derelict marshes on the Blyth that might be reclaimed, and a further aim is to discover what would happen to the harbour if a barrage was built to make this possible.

The work as a whole provided four conclusions about the existing harbour entrance. Waves coming from a direction south of normal produced the worst conditions. The period of the wave had little effect on the heights, but the film showed that a boat would be much safer on the long waves than on short ones of the same height. The height of waves in the entrance was much the same at half tide on flood and ebb as at high water, but the waves were very much lower at low water. Waves were commonly higher in the harbour entrance than they were at sea.

Five modifications to the harbour entrance have been tested. One of them proved to be fairly successful, but others are to be tried.

Shrewsbury Floods.

Plans are now being prepared for the second and larger of two models necessary to investigate the Shrewsbury flood relief scheme. The small, rigid bed model has been used on preliminary investigations, and the proposals of the relief scheme have now been incorporated in it for testing. The scheme includes channel improvements upstream and downstream of the existing weir at Shrewsbury, the removal of the weir and the installation of a set of semi-automatic sluice gates. One of the most important objects of the experiments is to find out if the cost of the scheme could be cut without reducing its effectiveness. The Station has also carried out work on another scheme for the River Severn—the proposed Maisemore Barrage.

Syphon for the Sudan.

The Station has designed an air-regulated spillway syphon for two falls on the Manaquil Branch Canal for the Sudan Irrigation Department. The function of the syphons is to maintain a constant upstream water level in the canal over a large range of discharges. Model tests were successful. They indicated that the syphon could pass 10 per cent. more than the designed full supply before reaching the safe limit of operation at which air-regulation ceases and the syphon runs full-bore.

Model Investigations of Tema Harbour and Breakwater.

Since the foregoing report was published, it has been announced that the Hydraulics Research Station at Wallingford has contracted to carry out two investigations for Sir William Halcrow and Partners, Consulting Engineers, in connection with a new harbour which it is proposed to construct at Tema on the Gold Coast.

One investigation will be carried out on a large model of Tema Harbour built to an undistorted scale of 1/120 in Wave Basin No. 1. This model will be used in studying the behaviour of long and short-period waves in and around the Harbour. Such tests are necessary to ensure that ships using the Harbour will be suitably protected from wave action. The present design of harbour in its various stages of development will be tested in the model and, subsequently, the effects of shortening the breakwaters, and of other modifications, will be examined. The model, and its associated equipment, is now under construction.

The other investigation is concerned with the stability of the breakwaters of Tema Harbour. These breakwaters will be constructed of large rubble, and will inevitably be subjected to severe wave action. Their behaviour under storm conditions is at present being studied on a model of a typical section of the breakwater built in the 54-ft. wave tank to an undistorted scale of 1/40. The tests will indicate in what way the large rocks—which will form the greater part of the breakwater—should be arranged and graded so that they will remain undisturbed by the largest waves. Various modifications of the original design are also being tested in order to minimise overtopping of the breakwater by waves.

New Marshalling Yards for Alloa and Port Talbot.

The British Transport Commission has announced details of improvement schemes to be started during the next two years for the modernisation of British Railways. Included in the schemes will be a marshalling yard to be built at Alloa, at a cost of nearly £500,000, to handle traffic from the new pits now being sunk in the Fife area. Another yard, costing nearly £3 million has been authorised at Millerhall, near Edinburgh. A new yard at Port Talbot, to cost £1,500,000, will also be put in hand.

"Hydraulics Research, 1954," is published for the D.S.I.R. by H.M.S.O., price 5s. 0d. (1 dollar 25 cents U.S.A.), by post 5s. 2d.

Manufacturers' Announcements

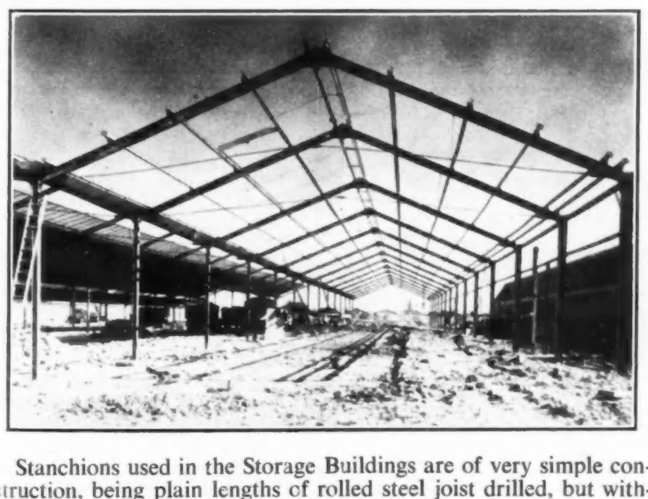
Portable Fire-Fighting Pump

The first demonstration in the United Kingdom was recently given of the Mars gas turbine, a small 40-75 h.p. unit which has been in production in the United States for some time and is now to be built at Crawley, Sussex. One of the main applications of the Mars is as motive power for a portable fire fighting pump, in which capacity it should prove an asset on shipboard. Its advantages are its light weight—less than 100 lb. for the basic engine—easy starting, and a period of 750 hours of service between overhauls. It is capable of pumping 480-500 gallons of water per minute at a pressure of 100 lb. per sq. inch. The unit can be operated in a number of other roles, such as a generator, a power unit for small craft or vehicles, and as a compressed air unit. Over 350 Mars units have already been manufactured by the Solar Aircraft Company, of San Diego, U.S.A., they are are to be produced in this country by a newly-formed company, Sugg Solar, Ltd. It is hoped that the first British-built units will be available in about a year's time.

New Range of Standard Buildings

Among the range of standard steel buildings manufactured and marketed by Sanders & Forster Ltd., Hertford Road, Barking, Essex, the Storage Building provides many novel features, both in design and construction. Based on the plastic or collapse theory, and using a tied portal frame as the basis of the design, a building has been developed which has the clean lines of the rigid portal frame, but which uses even less steel than the conventional truss and stanchion type of construction. This reduction in weight is achieved partly in the design and partly by departing from traditional structural practice and substituting simpler and more logical connections.

For planning purposes a 10-ft. module has been adopted, the bay length being 20-ft. This wide spacing of frames, 20-ft., as opposed to the more usual 12-ft. 6-in. or 15-ft., has many advantages from the user's point of view, and has been achieved without any substantial increase in the weight of the purlins. These are 4-in. x 1$\frac{3}{4}$-in. joists, and are fixed by a special form of pressed steel cleat, which introduces a very high degree of continuity at the joint, and keeps the deflection of the purlins within allowable limits. In the plane of the roof the purlins are connected by sag rods of a novel design, which hook into one another, ensuring accuracy of position and eliminating threaded ends and nuts.



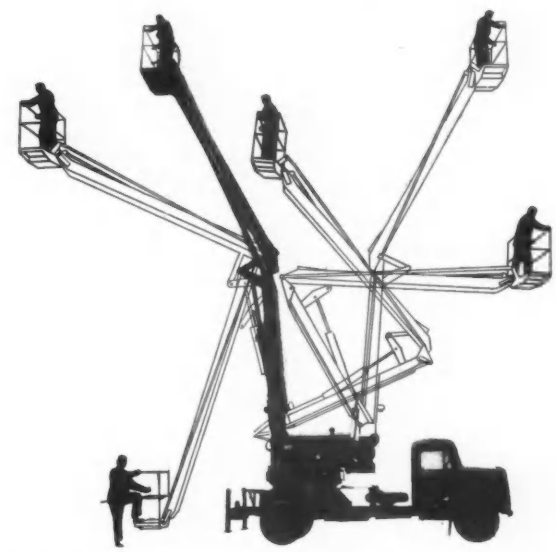
Stanchions used in the Storage Buildings are of very simple construction, being plain lengths of rolled steel joist drilled, but without caps or bases. The method of fixing is by planting the stanchions in pockets left in the concrete bases, and concreting in after the building is levelled and plumbed. Wall and roof bracing consists of $\frac{1}{2}$-in. dia. rods fitted with turnbuckles which provide a quick and accurate method of squaring the building up.

The maximum possible use has been made of welding in the shop fabrication of standard components. Site connections, however, are all bolted and a special detail has been devised at the apex of the roof frame to provide a rigid connection. The number of site bolts has been reduced to a minimum to speed up erection.

Any of the four standard spans, 30-ft., 40-ft., 50-ft. and 60-ft. can be erected as single spans, or combinations as required in a multi-span building. Four wall heights are available, 11-ft., 14-ft., 16-ft. or 20-ft. to eaves. Lean-to's 15-ft. or 20-ft. wide can be provided on the side of a high building, and there are two standard widths of canopy for use with any span which are particularly suitable for tropical conditions. Gable ends are constructed by hook bolting the gable stanchions onto a standard roof frame. Such a gable end can be easily dismantled and the building extended by adding standard frames.

Hydraulic Lift Platform

A versatile application of the hydraulic lift principle is to be seen in the Simon Hydraulic Platform recently demonstrated in London. As shown in the accompanying illustration, the Platform is capable of almost infinite variations of position. Control is from the platform itself (with duplicate controls at the turntable), and the operator can adjust his position in relation to the



job he is doing by means of pedals and a knee-operated rotation control, leaving his hands free for work. The lift is designed to lift to 40-ft. two men plus tools, and can be mounted in any chassis of three tons or over, or alternatively on suitable types of road trailer road truck, barge or pontoon.

The manufacturers are the Simon Hydraulic Machinery branch of Simon Engineering (Midlands) Ltd., Dudley, Worcs.

Loudhailer as Protection for Cables

Shore to ship installation of "Clearcall" loudhailer equipment has recently been supplied by the British Thomson-Houston Company, Ltd., to the Provincial Electricity Board of Zeeland, Holland, for warning shipping against dropping their anchors in a section of the Wester Scheldt, where high-tension cables are laid on the river bed.

The equipment includes a re-entrant horn driven by four special pressure units each rated at 50 watts and supplied by two 100 watt amplifiers, the signals being introduced by a continuous tape recorder, in both English and Dutch. The whole system is switched on or off at Flushing, some 17 kilometres away, this being effected through telephone relays and associated gear.

Intelligible speech can be expected up to five kilometres, but this may be greatly exceeded under favourable weather conditions. Prior to the installation of the "Clearcall" equipment, three of the 50-kv. cables were severed by a tanker; the cost of repairs amounting to £50,000.

Manufacturers' Announcements—continued

New All-purpose Tug

Recently shipped to Port Louis, Mauritius, where she will be used by British India Steam Navigation Co. Ltd., in their lighterage business, the diesel tug "Ailsa" was built at a fixed price and completed in 16 weeks from commencement.

The principal dimensions of the tug are:

Length O.A.	47-ft.
,, B.P.	42-ft. 6-in.
Breadth Moulded	12-ft. 9-in.
Draft Aft	5-ft. 3-in.
Displacement	30 tons
Block coefficient	0.45

The "Ailsa" is similar to the tug "Gannet" which was completed by the same builders last year and is now giving good service in Aden harbour. A form of double chine construction has been used and the vessel has a straight line camber, for simplicity in building. She is engined by a Crossley two-stroke direct reversing marine Diesel engine developing 150 bhp, with air starting and fresh water cooling.

On trials the tug obtained a mean speed of 8.4 knots at 450 r.p.m., and at the corresponding speed the bollard pull was 1.9 tons. The turning circle is approximately 100-ft.

The vessel was designed by Burness Kendall & Partners, and built by Thames Launch Works Ltd., Twickenham, Middlesex.

Dry Dock Contract for British Firm

The Pakistan Industrial Development Corporation has awarded the contract for Karachi's new dry dock to a British company, Gammon (Pakistan) Ltd., which has obtained the order in competition with engineering firms in France, Holland, Germany, and the United States.

The dry dock, which will form an essential part of Pakistan's shipbuilding programme, will accommodate vessels of up to 12,000 tons deadweight. It is expected to be completed by the end of 1957, when Pakistan will be in a position to increase its merchant fleet tonnage and avoid the need to send ships to Malta and Singapore for repairs.

Measuring 632-ft. long, 90-ft. wide, and 38-ft. deep, the dock will have incorporated in its structure a system of anchorage cables based on the use of prestressed wires; these are designed to hold down the dock floor and resist uplift caused by the pressure of water from the sea-bed.

The first phase of Pakistan's shipbuilding programme is almost complete; and the second part of the plan, which includes the dry dock, is now beginning. The whole scheme will cost about £6,750,000.

The Pakistan Industrial Development Corporation is also to establish shipyards in East Bengal, at Khulna and Narayanganj. The Khulna yard will have seven slipways and a dry dock large enough to take any vessels now used or likely to be used in the future in East Bengal.

Heavy Duty Plugs and Sockets

The cables and connectors of temporary electricity supplies frequently needed in shipyards and docks for ships under construction or repair have to withstand vigorous treatment. With this in mind, the Plessey Company Ltd., Ilford, Essex, have made a range of heavy duty plugs and sockets for joining electric cables which will withstand very rough handling without damage.

There are four basic housings, made of forged aluminium bronze, for plugs and sockets. These are: a Cable Unit, for terminating and anchoring cables; a Panel Unit, fitted with a flange for mounting in a fixed position, wiring connections being made directly into the rear; a Cable Coupler, to be used in conjunction with a Cable Unit when it is desired to join two cables; and a Panel Mounting Coupler, which is similar to a Panel Unit except that an outlet and fittings are provided to enable a cable to be connected at the rear.

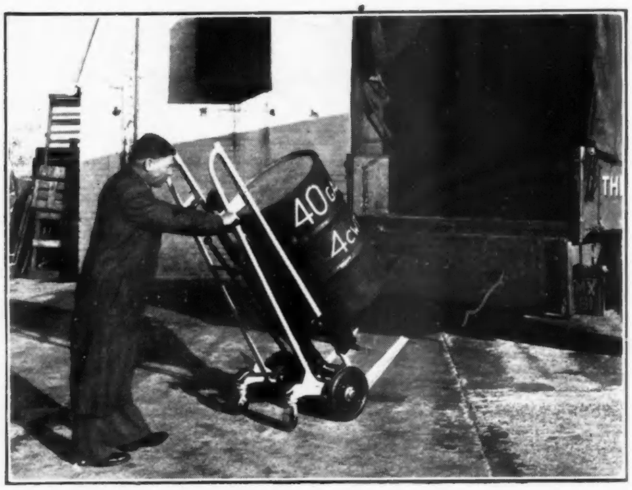
The housings are arranged to accommodate either a plug or socket fitting, which are interchangeable, in any of the three standard contact combinations.

Sherpa Hydraulic Truck

Claimed by its manufacturers to incorporate features never before introduced in a truck of this type, the new Sherpa II Handraulic truck is capable of lifting a maximum load of 5 cwt. to a height of some 4-ft. 10-in.

The framework is manufactured from heavy-gauge steel tube, welded throughout to ensure complete rigidity. The backplate, running on four hardened steel grooved-rollers, has provision for alternative fork positions, enabling a wide range of load sizes to be carried with safety. The forks remain parallel with the ground throughout their travel, and have a short ramp forged on the front to ease loading.

The load is raised by means of a hand-operated pump via pulley and roller chain. This pump is a self-contained unit, housing the piston, hydraulic ram and sump. It incorporates a dual-speed



piston by means of which the empty platform, or loads up to 2 cwt., can be raised twice as fast.

The main 12-in. dia. wheels, fitted with roller bearings and rubber tyres, have extra castor wheels above and behind them, positioned so that the maximum load can be pulled over with less fatigue and complete safety. To assist in the pulling over, a foot-operated lever shifts the fulcrum from the axle to a point below the front uprights. Aided by this lever one man can pull over 5 cwts. with ease.

The overall height of the Sherpa II is 5-ft. 10-in., the overall width without forks is 3-ft. 8-in. and the unladen weight is 2 cwt. The manufacturers are Salisbury Precision Engineering Ltd., Salisbury, Wilts.